NPS-SE-11-013

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

HUMANITARIAN ASSISTANCE SHELTER SYSTEM (HASS)

Stefan Bidigaray	Janet McKinney
Jaspal Brar	Jose Montes
William Fiery	Megan Nguyen
Dixon Hory	Joshua Seab
Eric Jarabak	Jacob Thomas
Whitney Kemmey	Jeffrey Wareham
Paul Lee	Benjamin Williams

September 2011

Approved for public release; distribution is unlimited

Prepared for Naval Postgraduate School

THIS PAGE INTENTIONALLY LEFT BLANK

NAVAL POSTGRADUATE SCHOOL

Monterey, California 93943-5000

Daniel T. Oliver
President

Leonard A. Ferrari
Executive Vice President and
Provost

This report was prepared for the Chairman of the Systems Engineering Department in partial fulfillment of the requirements for the degree of Masters of Science in Systems Engineering.

This report was prepared by:

Stefan Bidigaray
Jaspal Brar
William Fiery
Dixon Hory
Eric Jarabak
Whitney Kemmey
Paul Lee
Janet McKinney
Jose Montes
Megan Nguyen
Joshua Seab
Jacob Thomas
Jeffrey Wareham
Benjamin Williams

Reviewed by:

David Olwell
311-101 Capstone Project Advisor

Brigitte Kwinn
311-101 Capstone Project Advisor

Clifford Whitcomb
Chairman
Department of Systems Engineering

Released by:

Karl A. van Bibber, Ph.D.
Vice President and Dean of Research

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE						*Form Approved OMB No. 0704-0188*

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE *(DD-MM-YYYY)* 09-09-2011	**2. REPORT TYPE** Technical Report	**3. DATES COVERED *(From - To)*** 07-01-2011 – 09-09-2011
4. TITLE AND SUBTITLE Humanitarian Assistance Shelter System (HASS)		**5a. CONTRACT NUMBER**
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Bidigaray, S., Brar, J., Fiery, W., Hory, D., Jarabak, E., Kemmey, W., Lee, P., McKinney, J., Montes, J., Nguyen, M., Seab, J., Thomas, J., Wareham, J., Williams, B.		**5d. PROJECT NUMBER**
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		**8. PERFORMING ORGANIZATION REPORT NUMBER** NPS-SE-11-013
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		**10. SPONSOR/MONITOR'S ACRONYM(S)**
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES
The view expressed in this report are those of the authors and do not reflect the official policy or position of the Department of Defense of the U.S. Government.

14. ABSTRACT
As part of a Naval Postgraduate School's capstone project in Systems Engineering, the project team from Cohort 311-101O of the Naval Postgraduate School (NPS), performed a Systems Engineering analysis and verified the analysis with the acquisition and partial testing of the Humanitarian Assistance Shelter System (HASS). The HASS was developed in response to a need for a rapidly deployable mid-term shelter solution for disaster victims. There exists immediate shelter solutions for the victims, yet there is no transitional shelter available for the period between the demise of the immediate shelter and acquisition of permanent housing. For example, the displaced Haiti earthquake victims are still living in tents more than a year after the disaster has struck. This report documents the disciplined Systems Engineering approach used to determine the requirements, trade-offs, cost-effective solution, and testing required of the solution to fulfill the HASS stakeholders needs. Due to time constraint, partial testing on the HASS components was done with findings documented as well as recommendation for further testing and future work.

15. SUBJECT TERMS
disaster relief, temporary housing, integrated solution, transitional housing

16. SECURITY CLASSIFICATION OF: Unclassified			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON** Janet G. McKinney
a. REPORT Unclassified	**b. ABSTRACT** Unclassified	**c. THIS PAGE** Unclassified	UU	575	**19b. TELEPHONE NUMBER *(include area code)*** 540-284-0504

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

As part of a Naval Postgraduate School's capstone project in Systems Engineering, the authors performed a Systems Engineering analysis and verified the analysis with the acquisition and partial testing of the final design of the Humanitarian Assistance Shelter System (HASS). The HASS was developed in response to a need for a rapidly deployable mid-term shelter solution for disaster victims. Immediate shelter solutions exist for the victims, yet there is no transitional shelter available for the period between the end of useful life of the immediate shelter and acquisition of permanent housing. For example, the displaced Haiti earthquake victims are still living in tents more than a year after the disaster has struck. This report documents a disciplined Systems Engineering approach used to determine the requirements, trade-offs, cost-effective solution, and testing required of the solution to fulfill the HASS stakeholders needs. Due to time constraints, partial testing on the HASS components was done with findings documented as well as recommendation for further testing and future work.

THIS PAGE INTENTIONALLY LEFT BLANK

Acknowledgement

The authors would like to extend their gratitude and acknowledge the help received from the following individuals that contributed to the success of this thesis.

First of all, thanks to all of the students' families, spouses, significant others, children and parents. By providing support, patience and encouragement, they inspired the students to work diligently and persevere through each and every quarter of this program.

Thanks to our advisors, Dr. David Olwell and Professor Brigitte Kwinn, for their guidance, good humor, and fidelity to making sure that the Capstone team provided a quality product. They ensured that our efforts reflected the Naval Postgraduate School (NPS) mission: "high quality, relevant and unique advanced education and research programs that increase the combat effectiveness of the Naval Services, other Armed Forces of the U.S. and our partners, to enhance our national security."

Also, thanks to Ms. Jeannie McMahon, Worldwide Shelters, and Mr. Peyton Cascio, VersaTube for providing exceptional assistance in purchasing the shelter that was tested. Thanks to Master Chief Louis Jamieson, U.S. Navy, for sharing his knowledge of food preparation for small squads. Special thanks go out to our immediate supervisors and the management and command structure that sponsored us in this program. Thanks to Marine Corps Systems Command, Quantico, Virginia, for providing storage facilities, equipment, manpower assistance, and a location for our shelter to be erected. Thanks to the instructors at NPS who attended the interim reviews and asked thought-provoking questions, especially Dr. Donald Muehlbach.

Last but not least, thanks to our stakeholders who responded to our survey and provided advice during various interviews: Lieutenant Commander Mike O'Donnell, U.S. Navy, of the Pacific Fleet Civil Engineer Office; Mr. Dan Klingshirn, Humanitarian Assistance Program Manager for Naval Facilities Engineering Command (NAVFAC) Pacific; Captain Matt Myrick, U.S. Army, Humanitarian Assistance branch (J447) at U.S. Pacific Command; Mr. Charles Setchell, U.S. Agency for International Development /Office of U.S. Foreign Disaster Assistance (USAID/OFDA)'s Shelter, Settlements and Hazard Mitigation Advisor; and Ms. Renee Van Slate, OFDA Humanitarian Assistance Advisor. Their candid conversation and willingness to share their years of knowledge and experience in support of this project was tremendous.

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

APPENDICES

List of Figures

List of Tables

Executive Summary

The following report outlines the efforts conducted by the authors to conceive, develop, and ultimately build and test a Humanitarian Assistance Shelter System (HASS). This system was designed with joint assistance from the Navy's Pacific Command (PACOM) and the U.S. Agency for International Development (USAID) with the intent to improve humanitarian assistance shelters and their related components essential to daily survival. Systems Engineering methods and techniques were employed to refine the system concept, resulting in the construction of a HASS prototype system which is based on a traceable and rationalized set of requirements; a derived system architecture; and a customer-centric concept of operations (CONOPS).

Between 1974 and 2003 there were 6,367 natural disasters which affected a cumulative total of 5.1 billion people; resulting in the deaths of 2 million people. This resulted in 182 million persons made homeless and an estimated $1.38 trillion in damages. The top ten disasters of the past thirty years as well as the top ten recipients of humanitarian aid can be viewed below. (D.Guha-Sapir 2004)

Top 10 Disasters With the Highest Numbers Affected: 1974-2003				Top 10 Recipients of Humanitarian Aid	
Disaster type	**Year(s)**	**Country(ies)**	**Number of people affected**	**Country**	**Humanitarian Aid (USD)**
1. Drought	1987	India	300,000,000	Central America	682,829,892
2. Drought	2002	India	300,000,000	India	274,372,511
3. Flood	August 1988	China	223,000,000	Bangladesh	251,155,574
4. Flood	May 1991	China	206,000,000	China	247,515,742
5. Drought	1979	India	190,000,000	Egypt	196,477,016

Top 10 Disasters With the Highest Numbers Affected: 1974-2003				Top 10 Recipients of Humanitarian Aid	
6. Flood	1996	China	150,000,000	Mozambique	195,195,949
7. Flood	July 1993	India	128,000,000	Turkey	148,389,240
8. Flood	May 1995	China	114,400,000	Afghanistan	94,580,566
9. Flood	June 1999	China	100,000,000	Montserrat	84,831,338
10. Flood	July 1989	China	100,000,000	El Salvador	74,492,561

While the subject of disaster zones, refugee camps, and tent cities is not a pleasant one, investigating their specific details was crucial to understanding the daily trials of the victims of disasters, what their specific needs are, and just exactly how we could address them. This investigation led to a list of daily concerns to be addressed by a HASS ranging from basic shelter to avoidance of genocide. This list was then used as a guide throughout the conceptual design process; ensuring that the HASS attempted to address these issues head-on.

Unfortunately not all of these concerns could be addressed by the system to the level they deserve. There is a realistic limit to assistance, and one of the major accomplishments of this project was finding that balance. An extensive and in-depth approach was taken to looking at the problem, and an encompassing solution was found.

This system was developed in response to a need for a pre-packaged HASS with a progressive suite of capabilities to meet changing operational environments. Currently, the U.S. government does not have a pre-packaged humanitarian assistance shelter system, and their current shelter capability is not intended to last more than 6 months, leaving a capability gap in humanitarian assistance shelters between six months and the time permanent housing is available, which is usually three years. During those three years, victims who are not fortunate enough to find permanent shelter are forced to utilize whatever means they can find; whether that be tarps, local materials, or rubble to attempt to construct themselves a home. This ad hoc

method of survival poses many challenges to surviving victims, especially to their sense of security, privacy, health, and overall wellbeing; so while it is impossible to prevent someone from becoming a victim of a disaster, it is possible to prevent them from becoming a victim of their circumstances.

To address these issues, the HASS was developed to serve as the basis for permanent/transitional housing, and to provide more crucial services and capabilities to the user than are currently available. This will ultimately allow disaster survivors to feel more secure, be more self reliant, and aid in the overall communities' recovery through a context driven approach to shelter; whereby local materials are bought and salvaged to aid in re-construction efforts. This varies greatly from the vast majority of humanitarian aid operations, in which shelters are not transitional. Without such an evolution in humanitarian assistance shelters, victims of natural and manmade disasters will continue to face challenges of surviving in a post-disaster setting with insufficient capabilities to do so. These challenges, which the HASS has

addressed, are in the areas of safety, privacy, health, sustainment, reliability, and transition.

This conceptual design effort resulted in a sturdy shelter system capable of housing a family of between 5 and 10 people. This shelter system is capable of sustaining those occupants (less food, water, limited services, and general supplies) for a duration of no less than 2.5 years. During this time, the HASS is capable of purifying water, performing a variety of cooking functions, safely storing adequate amounts of food and water, and providing added security through solar powered lights and hand-cranked two way communication. The shelter frame then provides the basis for construction of a permanent form of housing.

The initial purchase cost of the HASS as tested has been estimated to be approximately $3,800 with a lifecycle (storage,) operation, and sustainment cost of an additional $1,200 resulting in a total lifecycle cost of $5,000 less transport costs. This price point represents the most capable concept variant which is the variant that underwent testing, not the concept variant chosen by the CAIV analysis. The concept variant chosen by the CAIV analysis is the most capable concept variant less the water purification and lighting capabilities. It was decided to procure and test the most capable system in order to perform more testing therefore acquiring data on multiple variants of the HASS.

HASS Life Cycle Cost Estimate			
Most Capable		**Threshold Req Only**	
Acquisition	$3800	Acquisition	$1450
LCC	$1200	LCC	$0
Transport	$500	Transport	$400
Total Implementation Cost		Total Implementation Cost	
$5,500		$1,850	

Although the variant tested exceeded the cost key performance parameter (KPP) of $2300 per unit for procurement and transportation, other concept variants are available that meet the KPP; however, these concept variants have less capability. For example, the concept variant that meets threshold requirements only has a cost of $1,450 and consists of no LCC costs.

In its current prototype configuration (most capable), the HASS requires 2 standard pallet positions or ½ of a standard 463L air transport pallet. This equates to a domestic shipping

charge of approximately $180 per HASS and an international shipping charge per HASS between $400-$500 based upon its destination and total items shipped.

This destination is almost always uncertain and the HASS' operational environment is heavily dependent on it, therefore, the team developed a standard concept of operations associated with the implementation and logistical delivery of such humanitarian aid. This standard CONOPS was derived from USAID's and the Navy's humanitarian assistance CONOPS and can be seen in the figure below. The HASS conceptual design was developed using this standard CONOPS along with research describing various operational environments. This conceptual design ensures a smoother acquisition, implementation, and integration process with current Humanitarian Assistance/Disaster Relief efforts being conducted by both stakeholders.

This standard humanitarian assistance CONOPS states that when a disaster occurs, the US Government activates the military disaster relief organizations either at the request of the local government or in coordination with the local government. At the same time, non-military relief organizations are immediately mobilized once approval is granted from their liaisons on the ground. These immediate mobilizations result in emergency shelter kits reaching the disaster sites usually within 72 hours of the event. These emergency shelters are then utilized and modified by the users to last as long as possible. However, these emergency shelters are not intended to last beyond six months, leaving a shelter capability gap of 6 months to 3 years.

Therefore, before the 6 month after the disaster event or, or as soon as the coordinating relief agency deems necessary, the HASS is moved from its storage location via standard pallet to the disaster site or some intermediate distribution center where further transport awaits.

The HASS is delivered and set up on-site by untrained disaster victims or disaster relief personnel staffed by Non-Governmental Organizations (NGOs). The HASS is then inhabited by the displaced persons with their emergency supplies for a prescribed duration of 2.5 years, after which the HASS may be disassembled and salvaged by the local population or utilized and transitioned into a more permanent form of housing with the aid of locally available materials. No part of the HASS is deemed recoverable by the stakeholder; the system is expendable.

The HASS will require minimal Preventive Maintenance Checks and Services (PMCS). The HASS will also be designed to meet a high operational reliability to require minimal repairs

over its operational life cycle. Any repairs will be completed by the untrained users with supplied tools, or the component will be designed to be easily replaced by the untrained users.

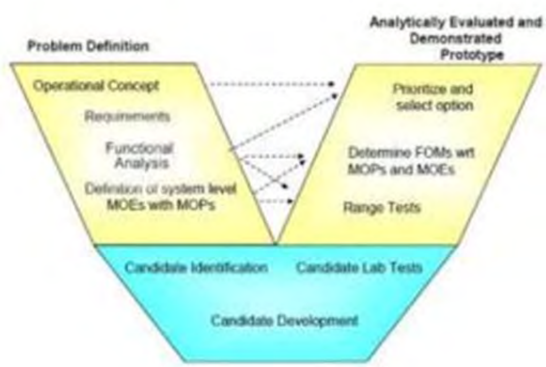
The HASS will also utilize a deployment and context driven design; meaning that if the stakeholder chooses, they will be able to deploy the HASS without some critical construction components (CCC) (i.e., wall or floors) to save cost. These CCCs will be assessed and chosen post-disaster based on what the stakeholder deems are the most locally salvageable materials. These CCCs will then be procured or salvaged by the user/stakeholder at or near the disaster site. This not only saves the stakeholder acquisition and transportation costs, but allows more funds to be injected into the local economy if the CCCs are purchased from local suppliers. The local government will also coordinate with the supplying relief organization to ensure that the HASS kits which they will receive are configured to the maximum extent possible for the local government's specific operational environment; thus saving costs associated with the transportation and implementation of unnecessary HASS components or features.

Upon refinement and completion of the HASS' CONOPS, multiple meetings were held with each stakeholder in order to get a grasp on their system needs. This information ultimately led to the development of a Mission Need Statement (MNS). The MNS and CONOPS then fed the development of the system's requirements and functional architecture, in turn, resulting in the creation of technical measures/metrics and Key Performance Parameters (KPPs) which the

soon to be realized concept variants could be judged on. Top Level System Requirements (TLSRs) with their integrated technical metrics were then integrated into an AHP pair-wise comparison process and manipulated by the stakeholders in order to prioritize and better understand the customers' needs and preferences.

The resulting prioritized list of TLSRs and technical metrics furnished the development team's ability to continue on with the system's conceptual design through a Quality Function Deployment (QFD) process, ultimately selecting system components and subsystems which would be used during a trade-off study and Cost As an Independent Variable (CAIV) analysis to determine the optimal concept variant based on customer needs.

Once selected, the optimal concept variant was then rapidly transitioned into the prototype development phase, whereby the selected components and subsystems were procured and integrated for preliminary Developmental Test & Evaluation efforts.



Throughout the HASS' development, the HASS team utilized the Rapid Prototyping Systems Engineering model to help achieve the desired capabilities the HASS required in the time allotted.

This rapid prototyping systems engineering approach to system development, while effective in its ability to quickly realize and produce concepts and prototypes, resulted in some possible shortcomings in the system's effectiveness. These shortcomings were entirely brought on by the project budget and schedule and were discovered during Developmental Test and Evaluation (DT&E) efforts. These DT&E efforts involved preliminary testing of the HASS and its systems in relevance to their abilities to meet their stated requirements. The shortcomings discovered during testing can be resolved through further research and DT&E efforts and the resulting solutions will be incorporated into future design to ensure a successful and effective system. A brief summary of these shortcomings can be viewed below.

- In development of candidate solutions the price points developed were the result of individual research into candidate solutions with priority on meeting individual physical

architecture component requirements and not price point. It is possible cheaper components exists within the trade space of requirements.

- Testing of the HASS system was limited in not only scope and breadth but time available; as a result, complete testing of the HASS system to the full level described in section 4 was not performed. The assumption based upon research was that the individual component solutions were able to meet the requirements defined; however, thorough testing to verify and validate the assumption was not completed as part of this project.

- The fielding and maintenance of the HASS system was considered as part of this project along with a full lifecycle cost; however, the implementation of the plans developed may not be complete or thorough enough for actual acquisition due to limited information or assumptions made to support this effort.

- Reliability and maintenance calculations were based upon assumptions determined by the project team to be best estimates. Actual reliability/preventive and corrective maintenance data needs to be acquired from actual field tests/user evaluations to accurately determine necessary reliability and maintenance performance requirements.

While these shortcomings press the need for further development, they validate the claims that a HASS was developed based on rigorous research, requirements generation, development, and systems engineering efforts, whereby crucial developmental/project issues were discovered and either addressed or reserved for further consideration.

"For the first time a solution to humanitarian aid shelter was developed based on joint developmental efforts in conjunction with rigorous systems engineering methods."

While further Research, Development, Test and Engineering Evaluation (RDT&E) may be necessary to optimize the HASS' operational effectiveness, a major milestone has been achieved in humanitarian aid in that for the first time a solution to humanitarian assistance shelters was conceived, developed, and tested based on joint developmental efforts in conjunction with rigorous systems engineering methods. This project

was the first time a prototype was assembled by a distance learning cohort. The project serves as an initial point for future acquisition planning and relevant developmental efforts by the HASS' stakeholders (USAID/U.S. Navy). From this point, limited developmental work would be required to transition the HASS to an operational test phase; including a limited user evaluation (LUE), upon which further refinement of the HASS could take place.

Before such a LUE, it may be prudent to conduct follow-on work with future students derived from captured shortcomings which may include but are not limited to:

- Complete testing of the HASS to all section 4 validation requirements of the HASS System Specification. The testing of some section 4 validation requirements was not performed as part of this effort due to limited time and resources.

- Field testing or limited user evaluation should be considered to help refine the solution to ensure the system will work as planned and all issues of fielding the system have been captured. Possible design changes may be necessary based upon field testing and/or a limited user evaluation.

- From the teams' communication with stakeholders of the HASS, it was discovered that in most cases the transitional shelter is used as the source and basis for a permanent shelter solution by the inhabitants. Research and testing needs to be performed to determine what materials and components can be integrated into the HASS in order for it to transition into a permanent shelter solution. Furthermore, the current frame design needs to be evaluated to determine if it is effective at being able to be integrated with locally available materials. The frame should be analyzed to determine if it can handle the severe operational environment requirements stated when integrated with locally available materials.

- From the team's communication with stakeholders of the system, it was discovered that in most cases the materials used to construct the shelters are acquired from within the country of the disaster. Research and testing into possible replacement materials for components of the system needs to be done to determine which Critical Construction Components (CCCs) are likely going to be available for construction of the shelter from the local community in various scenarios.

In conclusion, the Capstone Team (Cohort 101O) was able to conceive, develop, and test a novel HASS in conjunction with stakeholders while utilizing rigorous Systems Engineering methods. This ultimately resulted in a HASS prototype, which possesses an traceable design based upon detailed research. This project provides the humanitarian aid community detailed design documents and a good process for further systems engineering.

A full copy of any HASS documentation/products resulting from this effort are available upon request to the Naval Postgraduate School.

HASS Documentation/Products Available
HASS Capstone Project Report
Project Management Plan
HASS System Specification
HASS Mission Need Statement
HASS Concept of Operations
Total Implementation Cost
HASS Maintenance Concept
System Traceability Documentation & System Architecture (Available in CORE Software)
HASS Configuration Management Plan
HASS Test Report

.

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Description
AC	Alternating current
AHP	Analytical Hierarchy Process
AoA	Analysis of Alternatives
CAIV	Cost As an Independent Variable
CCC	Critical Construction Component
CONOPS	Concept of Operations
CONUS	Continental United States
COTS	Commercial Off The Shelf
CPT	Captain (U.S. Army)
CSCM	Master Chief Culinary Specialist (U.S. Navy)
DC	Direct current
Deg F	Degrees Fahrenheit (temperature)
DOD	Department of Defense
DT&E	Developmental Test and Evaluation
Ext	External
FED-STD	Federal Standard
FFBD	Functional Flow Block Diagram
g	Grams
Grms	Gravity root mean squared (measure of acceleration)
H	Height
HASS	Humanitarian Assistance Shelter System
HA/DR	Humanitarian Aid/Disaster Relief

Acronym	Description
HOQ	House of Quality (see AHP)
HSCWB	High Stress Collapsible Water Bag
I&P	Investment and Procurement
ICRC	International Committee of the Red Cross
IDEF0	Integration Definition for Function Modeling (functional modeling methodology)
IFRC	International Federation of the Red Crescent
In	Inch
INCOSE	International Council on Systems Engineering
IPT	Integrated Product Team
kHz	Kilohertz
KPP	Key Performance Parameter
L	Liter
lbs	Pounds
LCCE	Life Cycle Cost Estimate
LCDR	Lieutenant Commander (U.S. Navy)
LUX	Lumens per square meter
MHz	Megahertz
MIL-STD	Military Standard
MNS	Mission Need Statement
MOE	Measure of Effectiveness
MOP	Measure of Performance
mph	Miles per hour
NDIA	National Defense Industrial Association

Acronym	Description
NGO	Non-Governmental Organization
NPS	Naval Postgraduate School
O	Objective
O&S	Operation and Sustainment
OFDA	Office of Foreign Disaster Relief (part of USAID)
OMOE	Overall Measure of Effectiveness
OT&E	Operational Test and Evaluation
OV	Operational View
PACOM	United States Pacific Command
PM	Program Manager
PMCS	Preventative Maintenance Checks and Services
PMP	Project Management Plan
QFD	Quality Function Deployment
Qt	Quart
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
SE	Systems Engineering
Sec	Second
SV	System View
T	Threshold
TLSR	Top Level System Requirement
TPM	Technical Performance Measure
UNHCR	United Nations High Commissioner for Refugees

Acronym	Description
US	United States
USAID	US Agency for International Aid
V	Volts
W	Width

1. Introduction

The Humanitarian Assistance Shelter System (HASS) was developed by Cohort 311-101O of the Naval Postgraduate School (NPS) in response to a need for a rapidly deployable shelter solution for disaster victims. The effort commenced with a statement defining the problem, and identification of potential stakeholders. Systems engineers decomposed requirements down to detailed elements, integrated those elements, and verified system performance during the acquisition of the HASS. The team utilized necessary structural and technical elements of systems engineering for product development. Multidisciplinary activities which led to requirements analysis, design trades, and integrated product-process development were used to determine what system best addressed the need for a shelter solution. Structured methods, decision analysis and quality engineering foundations were emphasized. The systems acquisition and development are herein presented and discussed.

The HASS project focused on one aspect of Humanitarian Aid/Disaster Relief (HA/DR), specifically the provision of shelter to distressed persons or victims of a disaster. Currently, the United States (US) government does not have a shelter system in place specifically designed to support HA/DR operations. The purpose of the HASS project was to develop and analyze possible shelter concepts by utilizing systems engineering tools and techniques. This allowed the project group to make an informed recommendation to the system's stakeholders as to which system concept would best meet their need. At a minimum, the system should provide shelter to the user for a pre-determined period of time. Additional capabilities may be provided based upon customer requirements, though these capabilities may be constrained due to funding limitations. Some of these additional capabilities could include heating, ventilation, food preparation and storage, water purification and storage, sanitation, hygiene, communication, and improved setup/logistical capabilities.

In the last ten years, a number of severe natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, shelter and medical care become critical survival needs. The US is often a first responder in these events.

To serve the needs of displaced victims of disaster, the HASS must deploy and provide a shelter structure which can protect its occupants and serve their basic needs. Deployment

includes set-up by untrained users (often with the assistance of locally-operating Non-Governmental Organizations [NGO]). The shelter may be connected to other shelters in order to accommodate larger families or perform other uses.

The Capstone team of Cohort 311-101O, NPS Monterey is listed below in Table 1-1.

Table 1-1 Capstone Team

Name	Contact Email
ADVISORS	
Dr. David Olwell	dholwell@nps.edu
Professor Brigitte Kwinn	btkwinn@nps.edu
TEAM MEMBERS	
Stefan Bidigaray	smbidiga@nps.edu
Jaspal Brar	jsbrar@nps.edu
William Fiery	wefiery@nps.edu
Dixon Hory	dhory@nps.edu
Eric Jarabak	ejarabak@nps.edu
Whitney Kemmey	wwkemmey@nps.edu
Paul Lee	plee@nps.edu
Janet McKinney	jgmckinn@nps.edu
Jose Montes	jamontes@nps.edu
Megan Nguyen	mmnguyen@nps.edu
Joshua Seab	jwseab@nps.edu
Jacob Thomas	jathoma1@nps.edu
Jeffrey Wareham	jswareha@nps.edu
Benjamin Williams	bswillia@nps.edu
STAKEHOLDERS	
Dan Klingshirn	Daniel.Klingshirn@Navy.Mil
CPT Matthew Myrick	Matthew.myrick@pacom.mil
Charles Setchell	csetchell@usaid.gov

1.1 Background Research

The HASS team conducted a review of existing literature about humanitarian relief efforts in the wake of natural disasters, specifically focused on the problem of providing shelter to displaced victims of natural disaster. The information learned during this process helped identify stakeholders, formulate interview questions for those stakeholders, and begin to refine our problem definition. The team became familiar with the general problem, existing approaches to solving the problem, and gaps in current solutions.

The most helpful sources of information were government agencies and associated organizations involved in humanitarian aid and disaster relief. For example, the United Nations (UN) publishes a document entitled *Shelter Projects 2008* (UN-HABITAT and IFRC 2009), as well as a later version called *Shelter Projects 2009* (UN-HABITAT and IFRC 2010), that both provide a wealth of documentation on many historical disasters and respective shelter responses. A discussion of areas impacted are described in detail, statistics on quantity of victims displaced, logistics and supply information, implementation, costs, technical description of shelter solutions deployed, and the strengths and weaknesses of each shelter project. This data provides context into various potential operational scenarios based on actual disasters and associated projects, which enabled our team to gain a better understanding of the geographic areas that had been impacted by various disaster types over time, and gain insight into different emergency and transitional shelter solutions deployed.

In June, 1992, the United Nations established the Inter-Agency Standing Committee (IASC) (IASC 2011) to strengthen humanitarian assistance throughout the world. This committee is the primary mechanism for inter-agency coordinated assistance. The committee provides a forum for coordination, policy development, and decision-making involving key UN and non-UN humanitarian partners. Another agency established by the UN is the United Nations High Commissioner for Refugees, whose mission is to "lead and coordinate international action to protect refugees and resolve refugee problems worldwide" (UNHCR 2011). The UNCHR publishes the *UNHCR Handbook for Emergencies* (UNHCR Handbook for Emergencies n.d.), which provides in depth information into protection of refugees, emergency management, and operations (e.g., food and nutrition, water, sanitation, supplies and transport, etc.). This

reference provided information about communal services, logistics, and other issues of emergency management which helped frame the problem boundaries of the HASS. These UN documents also provided insight into the complexities of relief shelter over long periods of time, and the requirements for shelter in various scenarios and at different points after a disaster event.

Interestingly, by this point in the project the team had not decided to focus on the under-served gap between decay of initial emergency shelter and availability of permanent housing, i.e., transitional shelter. However, the team was gaining the background information and formulating the interview questions that would later allow our stakeholders to guide us in this direction.

Also by this point in the project, the team had an initial list of stakeholders, but continuing research helped refine that list. The Congressional Research Services' *Haiti Earthquake: Crisis and Response* (Margesson and Taft-Morales 2011)provided insight into the organizations that were involved in Haiti's disaster response and their roles. The team learned who the potential stakeholders are with respect to humanitarian disaster response. Some of the organizations described were the Department of Defense (DoD), the U.S. Agency for International Development (USAID), the State Department, the Department of Homeland Security, and The International Federation of the Red Cross and Red Crescent Societies (IFRC). Later, the stakeholders would come from some of these organizations.

The United States (US) Government has long seen the need to provide humanitarian aid to disaster victims, and in 1961, the USAID was established with the twofold purpose of furthering America's foreign policy interest in expending democracy and free markets, while also improving the lives of citizens of developing countries. (USAID 2010) USAID actively contributes to IASC initiatives. An important work that USAID has actively supported over the past 14 years is the development of The Sphere Project (Sphere 2004).

The Sphere Project, launched in 1997 by a group of humanitarian Non-Governmental Organizations (NGOs), the Red Cross, and Red Crescent movement, is an initiative to define and propagate the standards by which the global community responds to natural disasters. The project publishes a handbook called *The Sphere Handbook—Humanitarian Charter and Minimum Standard for Disaster Response*, the latest edition published in 2004. (Sphere 2004) In 2000, the UN's IASC formally endorsed the Handbook and called on all of its members to use it.

For the HASS team, The Sphere Project provided information on widely varying issues from cultural sensitivities during disaster response to the minimum acceptable shelter space for "dignified accommodations".

Finally, the team discovered a Swiss-based NGO called the Shelter Centre, which supports the sector of humanitarian operations that responds to the transitional settlement and reconstruction needs of populations affected by conflicts and natural disasters. Shelter Centre is concerned with the transitional period following the emergency phase until durable solutions are reached. The project keeps a comprehensive library of reports, analysis, projects, and many other publications, including the IASC's Shelter Projects documents. For the HASS team, the most important Shelter Centre publication is the *Transitional Shelter Standards*, a document listing requirements for transitional shelter solutions. (Shelter Centre 2010). The *Transitional Shelter Standards* document references The Sphere Project, and has received funding for its development from USAID. Based on the references cited and participating members, it is evident that cross-organizational collaboration is occurring in maturing these humanitarian shelter related projects and documents. The *Transitional Shelter Standards* was leveraged by the HASS team for development of both the Mission Needs Statement (MNS) and the System Specification for the HASS. It was a primary source for many requirements of the HASS.

The HASS team's research into the existing state-of-the-art for shelter solutions and disaster relief management helped us to refine our research problem. The team gained perspective on the existing approaches, and learned where these approaches were falling short. Based on the research completed, the team was able to direct questions to expert stakeholders, and ultimately solidify the problem definition, MNS, and system specification.

1.2 Defining the Problem

A capability gap exists in HA/DR shelters. There does not now exist a prepackaged system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter (immediate post-disaster to +6 months post-disaster), and subsequent permanent housing (+3 years post-disaster) (Klingshirn, et al. 2011). In order to support future US Government humanitarian missions, a transitional shelter is needed that is transportable, protective, of adequate size, reliable, maintainable, compatible with basic

services, designed for an operational lifecycle of at least 2.5 years, securable, and private. (Klingshirn, et al. 2011).

Shelter occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded; whereupon, some components may be salvaged and re-used. The HASS may also be transitioned into permanent housing by utilizing local or salvaged materials by integrating these materials into the HASS frame structure.

Finally, the shelter system must be storable for long periods, and must be pre-packaged on pallets (“palletized”) for transport by land, air or sea. Once deployed, the shelter must interface with its occupants, the environment, and possibly other connected shelters.

1.3 Assumptions

To implement the HASS Operational Concepts, the team developed a number of core assumptions. These were collected as a list which evolved through the life of the project. Table 1-2 provides a complete list of assumptions for the project.

Table 1-2 HASS Project Assumptions

Regional and global catastrophes will continue to occur throughout the world.
The United States (US) will continue to consider responding to Humanitarian emergencies throughout the world to be within its interests.
US Department of Defense (DoD) and Merchant Marine assets will continue to provide Humanitarian Relief supplies, equipment and manpower in areas affected by regional and global catastrophes.
The U,.S. Agency for International Development (USAID), in cooperation with non-governmental organizations (NGO) and U.S and/or foreign military resources, will decide to create Humanitarian Relief ‘Communities’ in affected disaster areas; these communities will be established and supported by US resources.
HASS shelters will be considered for use in supporting affected populations *after* immediate emergency needs have been satisfied within the disaster area.
USAID, in cooperation with NGOs and US/foreign military resources, will make decisions to deploy

numbers of HASS shelters to meet identified needs in disaster area locations worldwide. (Note that the HASS shelter may be suitable for most disaster recovery support uses but may not be suitable for all. Disaster response planners may need to take into account that providing HASS shelters to some affected populations might impact local workers willingness to build back their communities, owing to a loss of incentive.)
HASS shelter component vendors will have the capacity to manufacture sufficient numbers of components within identified time constraints to support identified needs, and deliver them to designated US disaster staging location(s).
NGO, US military or US contract resources will have the capability to palletize HASS systems at designated US disaster staging location in sufficient numbers and time constraints to meet identified needs. HASS systems may be palletized in real time, or complete palletized HASS shelters may be stored at designated US disaster staging location(s) in quantities sufficient to respond to a disaster.
NGOs or US/Foreign military resources will plan and prepare sites for disaster recovery communities within the disaster area. Site preparation will include drainage and sanitation provisions.
NGOs or US/Foreign military resources will make resources available to transport palletized HASS shelters to the identified community site in the disaster-affected area.
NGOs or US/Foreign military resources will secure palletized HASS shelters at the affected disaster recovery community site.
NGOs or US/Foreign military resources will distribute HASS shelters to the affected population and provide basic guidance and/or minimal assistance in their assembly.
No skilled labor exists or is available within the disaster-affected population to assemble or maintain HASS shelters.
NGOs, US/Foreign military resources or members of the disaster-affected population will remove rubble from specific locations on disaster recovery community sites, where HASS shelters are to be assembled.
Members of the disaster-affected population will assemble the HASS shelters with minimal guidance/assistance from NGOs or US/Foreign military resources.
NGOs or US/Foreign military resources will provide separate support to Humanitarian Relief 'Communities' such as cookable food, water and fuel.
NGOs or US/Foreign military resources will provide latrine facilities and may provide bathing/shower facilities.
NGOs, US/Foreign military resources, or the local government will provide a separate Waste Management Capability for human waste and garbage/trash/debris.
NGOs, US/Foreign military resources or the local government will also provide Humanitarian Relief 'Communities' with a separate Physical Security Capability. Disaster-affected populations will receive security

services in addition to the basic capabilities provided by the HASS.
NGOs, US/Foreign military resources or the local government may also support Humanitarian Relief 'Communities' with an external source of electric power.
Members of the disaster-affected population will maintain the HASS once it is deployed.
Members of the disaster-affected population who occupy HASS shelters will continue to make use of items acquired during the Disaster Emergency Response effort. Members of the disaster-affected population will retain mosquito nets, interior furnishings, bedding, clothing/toiletries/personal items and any other items.
NGOs or US/Foreign military resources will not have an interest in recovering deployed, assembled HASS shelters from disaster locations. The HASS will be deployed only once and will not be recovered, reclaimed or disposed by the stakeholders/providing party.

1.4 Systems Engineering Process

The HASS team utilized the Rapid Prototyping Systems Engineering model (Cannon 2011) to help achieve the desired capability. The model was tailored due to time and budget constraints associated with the project. The Rapid Prototyping diagram shown below in Figure 1-1 is as depicted in its original form briefed at the 9th Annual National Defense Industrial Association (NDIA) Systems Engineering Conference in 2006 (Cannon 2011). The "V" represents the sequence of steps to quickly prototype a material solution with consideration taken to systems engineering. It describes the activities and results that will be produced during product development. The left side of the "V" represents definition and decomposition. The right side of the "V" represents integration of parts and qualification of the system.

The Rapid Prototyping Systems Engineering "V" model depiction below is requirements-driven, and starts with identification of user requirements. When these are understood and agreed upon, they are then placed under project control, and through decomposition the system concepts and system specification are developed. The decomposition and definition process is repeated over and over until; ultimately, piece parts are identified. Agreement is reached at each level, and the decisions are placed under project configuration management before proceeding to the next level. When the lowest level is defined, we move upward through the integration and verification process on the right leg of the V to ultimately arrive at the demonstrated prototype. At each level there is a direct correlation between activities on the left and right sides of the V – the rationale for the shape.

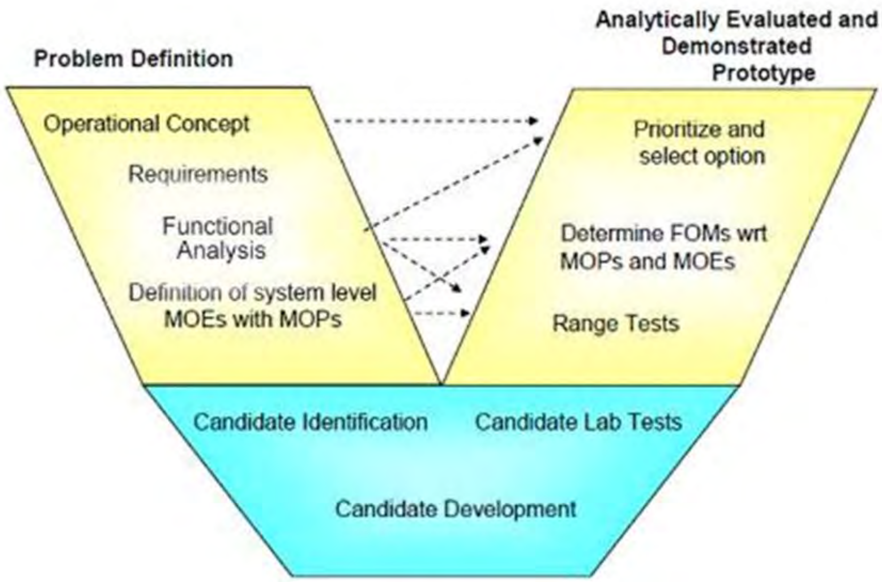


Figure 1-1 Rapid Prototyping Systems Engineering Model

Source of the picture is (Cannon 2011).

The V-Model provides guidance for the planning and realization of projects. The following objectives are intended to be achieved by the HASS system:

Minimization of Project Risks: The V-Model improves project transparency and project control by specifying standardized approaches and describing the corresponding results and responsible roles. It permits an early recognition of planning deviations and risks and improves process management, thus reducing the project risk.

Improvement and Guarantee of Quality: As a standardized process model, the V-Model ensures that the results to be provided are complete and have the desired quality (Sheard 1998). Defined interim results can be checked at an early stage. Uniform product contents will improve readability, understandability and verifiability.

Reduction of Total Cost over Rapid Prototyping effort: The effort for the development and rapid prototyping can be calculated, estimated and controlled in a transparent manner by applying a standardized process model. The results obtained are uniform and easily retraced. This reduces the acquirers' dependency on the supplier and the effort for subsequent activities and projects.

Improvement of Communication between all Stakeholders: The standardized and uniform description of all relevant elements and terms is the basis for the mutual understanding between all stakeholders. Thus, the frictional loss between user, acquirer, supplier and developer is reduced.

Rapid Systems Engineering Steps

Rapid development and deployment of new capabilities can be accelerated with this approach as presented by NDIA. This depends heavily on the steps used in the process and the amount of iteration necessary to achieved desired results. Rapid development requires a multi-disciplinary approach using the following steps captured in Table 1-3.

Table 1-3 Steps in the Rapid Systems Engineering Process

STEPS FOR RAPID PROTOTYPING	DEFINITION
Problem Definition	The problem definition asks the question, "why do we need this product". It is stated in terms of *what* must be done, not *how* to do it. It should express the customer requirements in functional or behavioral terms. The HASS project team published the problem definition in the Mission Needs Statement to bound the issue that required resolution.
Operational Concept	Addresses how the customer will use the system and captures description of the top-level functions that the system must perform in its operational environment. The HASS team interviewed potential stakeholders to help determine the operational concept.
Requirements	Customer needs are translated into a set of requirements that define what the system must do and how well it must perform. Analyze the customer's needs to identify the operational, performance, design and functional requirements. Weighting of top-level requirements is completed during this step. The HASS team reviewed the Mission Needs Statement (MNS) and translated customer requirements into technical terms. The final system requirements were documented in a System Specification that included system-level and subsystem requirements along with their respective verification methods.

STEPS FOR RAPID PROTOTYPING	DEFINITION
Functional Analysis	Clearly describes system functionality and is based on input provided by requirements analysis in the previous step. This step divide functions into sub-functions and allocates sub-functions appropriately to subsystems. The functional architecture defined top-level system requirements and decomposed them to the level necessary to determine components. Components were then selected based on functions and grouped as necessary. The HASS team utilized the Quality Functional Deployment methodology to execute this step.
Definition of System Level MOPs and MOEs	Define operational measures of success that are closely related to the achievement of mission or operational objectives. Characterize the physical or functional attributes relating to the systems operation. Define performance of the system.
Candidate Identification	Identification of potential components and subsystems which meet requirements. Once the functional architecture was completed and the system requirements documented, candidate components were identified. A multitude of candidates were considered for the HASS in this step.
Candidate Development	Maturing technologies or components to meet requirements of the system. Innovate, improve upon, modify, or otherwise alter its already existent products to meet design, performance and functional requirements of the system. Due to time constraints and the acquisition of Commercial Off-The-Shelf (COTS) items, the HASS team did not complete this step.
Candidate Lab Test	Verification testing to ensure candidates meets system requirements. This involves integration of all the components or a subset for testing. This step identifies risk areas and limitations. This step was not completed by the HASS project team but vendors for components tested individual components at their respective facilities.
Range Tests	Prototype testing and production estimates. This step confirms pre-test mathematical analysis by testing products on a system level basis. This step also executes final “go” or “no-go” for system components. User evaluation can take place during range testing. The HASS project team published an abbreviated test plan that detailed how the HASS was to be tested. Although approved ranges were not utilized, minimal testing on the HASS was performed at Quantico, Virginia.

STEPS FOR RAPID PROTOTYPING	DEFINITION
Determine FOMs with respect to MOEs and MOPs.	The Figures of Merit chosen were expressed in terms of Measures of Effectiveness (MOE) and Measures of Performance(MOP). This step determines that the object models are consistent with the established MOEs and MOPs. Test results are analyzed to ensure compliance with systems requirements for each candidate. User evaluation can be performed in this step to aid in final candidate selection. The HASS project utilized a program called CORE to map MOEs and MOPs.
Prioritize and Select Option	Score candidate options using a scoring matrix. Select the "Best Functionality" from the scoring matrix. Consider tool support and consulting. Look at price considerations for system affordability. The HASS project team selected the best candidate based on the requirements, cost and availability. Minimal scoring was executed for this program.

Rapid Prototype Systems Engineering Model Conclusions

The Rapid Prototyping Systems Engineering "V" model was used due to the fact that rapid response was required with application of systems engineering rigor. This process was selected based on the following systems engineering objectives:

- Systems Engineering can be tailored to rapid prototyping while maintaining rigor
- Understanding key constraints and the larger context provided a decision-making framework for the project
- Selection of SE tools facilitated the decision-making process
- The systems engineering team helped link users and technology providers together to produce an effective collaboration
- Parallel COTS Integration reduced overall risk of the project
- Priority given to the project varied across participants

1.5 The Management Process

The Program Manager (PM) is responsible for managing the project. For the HASS team, the team leader served as the PM, assuming oversight in many areas and synthesizing the resulting efforts and products to ensure the project met cost and schedule objectives. The first

step in the management process was to define the problem in order to identify the scope of work. With a problem definition in place, the team established goals for the HASS and allotted various goals to interim progress teams (IPT). The IPTs then evaluated and refined the goals in order to develop a set of firm requirements for the system.

Among the key programs reporting directly to the PM were: risk management, configuration management, program planning, cost tracking and product procurement. Risk management developed from the begging of the project with a collection of risk items from IPTs, stakeholders and advisors. Risks were evaluated and graded in order to create a risk matrix, which was tracked throughout the program. High-risk items were assigned mitigation plans to minimize or eliminate the risk. Configuration management involved identifying the configuration of the system in which the changes to configuration of the system were controlled thereby maintaining the traceability of the changes in an organized manner.

A schedule manager was assigned to oversee the master program schedule, tracking various milestones and advising the PM and task leads on recommended courses of action. Task leads were identified for all major items within the schedule, and coordinated directly with the scheduler.

A budget was established at the commencement of the program at $10K. Expenditures were authorized by majority decision based on analysis of alternatives (AoA) activities (described in detail below in section 3.2.1). Authorized expenditures and procurement was conducted through US government purchasing offices some three months prior to the completion of the project.

2. Problem Definition

To determine the capability gap that exists in HA/DR shelters as well as come to an optimal solution to fill that capability gap, a concise set of steps was implemented to accurately articulate a problem definition; ultimately resulting in a set of requirements and metrics which formed the structural backbone of the system conceptual design.

This process began with a stakeholder analysis in order to determine relevant stakeholders to the HASS. Once these stakeholders were identified, multiple meetings were held with each stakeholder in order to get a grasp on their system needs as well as their perceived operational concept scenarios. This information ultimately led to the development of a MNS and CONOPS for the HASS. The MNS and CONOPS then fed the development of the system's requirements and functional architecture; in turn, resulting in the creation of technical measures/metrics and Key Performance Parameters (KPPs) which the soon to be realized concept variants could be judged on. These Top Level System Requirements (TLSRs) with their integrated technical metrics were then integrated into an AHP pair-wise comparison process and manipulated by the stakeholders in order to prioritize and better understand the customers' needs and preferences.

The resulting prioritized list of TLSRs and technical metrics furnished the development team's ability to continue on with the system's conceptual design through a Quality Functional Deployment (QFD) process; ultimately selecting system components and subsystems which would be used during a trade-off study and Cost As an Independent Variable (CAIV) analysis to determine the optimal concept variant based on customer needs.

Once selected, the optimal concept variant was then rapidly transitioned into the prototype development phase; whereby the selected components and subsystems were procured and integrated for preliminary Developmental Test & Evaluation (DT&E) efforts.

2.1 Stakeholder Analysis

Based upon the problem definition and research into the problem domain, the HASS team created a list of stakeholders and questions addressed to those stakeholders. Given our focus on

US Department of Defense involvement in disaster relief operations, our initial list of stakeholders included the following:

- Department of Defense
- Department of Homeland Security
- State Department
- Department of the Interior
- US state and local governments
- Foreign governments
- Red Cross
- Red Crescent
- Vendors and contractors
- Disaster victims
- Disaster relief volunteers
- Disaster response organizations

As the HASS team continued to refine the scope of our problem (for example, focusing on disaster relief in third world countries outside the United States), our primary targets became the US State Department, specifically the US Agency for International Development (USAID), and the US Navy. These stakeholders were identified as decision makers for any purchases resulting from the HASS project or similar efforts.

During the problem definition phase of the HASS project, stakeholder involvement was impeded by current relief efforts in Haiti and Japan. However, the HASS team was able to work with the following stakeholders who gave generously of their time to assist us with the HASS project:

- LCDR Mike O'Donnell, N01CE32, Fleet Civil Engineer Office
- Dan Klingshirn, Humanitarian Assistance Program Manager, NAVFAC Pacific
- CPT Matt Myrick, J447 USPACOM Humanitarian Assistance
- Charles Setchell, USAID/OFDA’s Shelter, Settlements and Hazard Mitigation Advisor
- Renee Van Slate, OFDA Humanitarian Assistance Advisor

The HASS team was not able to conduct interviews with all stakeholders due to individual involvement in ongoing relief efforts. The HASS team invited stakeholders to significant project briefs. Stakeholders were also given an opportunity to review project materials such as the Mission Needs Statement. Finally, stakeholder priorities were captured using a pair-wise comparison process.

Interviews began with a list of questions submitted to the stakeholders for review prior to the interview; follow-up questions were allowed as the discussion warranted. Examples of the interview questions include:

- Shelter design
  - How portable should the shelter be?
  - What is a reasonable size for the system and what number of persons will it support?
  - What is a reasonable cost goal per unit?
  - Should the shelter be raised off the ground?
  - Is it acceptable to expect the user to repair the shelter?
  - How important is it for the shelter to be reusable?
  - How long can be taken to set up the shelter?
  - Do you expect the inhabitants to set up the shelters or a trained team to set up a series of shelters?
  - What type of protection provisions should the shelter include? Locks? Rodent and bug protection?
- Logistics
  - What is a reasonable number of these systems to stockpile?
  - How many people are expected to need support?
  - What is the concept of operations for the delivery, storage, and employment of these systems?
  - What are reasonable assumptions about the supporting infrastructure available to the systems? What logistical support will be available? External power/water/food?
  - Does the HASS team need to address disposal of the shelter?

- Operation
    - What would you want a disaster shelter to accomplish?
    - How long are the people going to need the shelter?
    - What are reasonable environmental assumptions? Weather and ground conditions for operation?
    - What operational scenarios might be useful?
    - What are general Measures of Effectiveness for the shelter?
    - What type of services should the shelter perform for its occupants? Water purification? Cooking capabilities? Storage capabilities? Hygiene capabilities. Generate power? Lighting? Sleeping provisions?

The various stakeholders provided invaluable input to the HASS project. A short summary of each stakeholder's insights and perspective is included below:

Dan Klingshirn

The team's first interview with Mr. Klingshirn was conducted on March 16, 2011. From Mr. Klingshirn the HASS team learned that the DoD only responds to five percent of disasters worldwide. USAID transports shelters using contractors, and relies on Non-Governmental Organizations (NGO's) to erect the shelters and run camps. Shelters could house ten to fifteen people.

Cost is definitely a concern, but durability is important, since the end user cannot be expected to perform maintenance, and the shelter may need to withstand aftershocks. The tarps that USAID distributes last about nine months in Haiti.

According to Mr. Klingshirn, the short-term, emergency need is currently met very well. However, there is a gap between the emergency need served by USAID tarps and the long-term need served by permanent structures. This gap is currently underserved. If addressing this gap, it doesn't really matter if it takes a month or more to set up a shelter, since emergency shelter will be available while transition shelter is constructed.

As for services provided by the shelter, water and sanitation are extremely important. In Haiti, cholera was a big problem. Usually waste is taken care of by latrines or septic systems installed by NGO's on a community scale, but clean drinking water is often a problem. Any

water purification or filtration system would need to operate without re-supply. Infrastructure is not likely to be available.

Measures of Effectiveness could include flexibility to respond to different disaster scenarios, durability, cost, ease of transportation and setup, and scalability to different numbers of displaced people (10,000 to 100,000).

Finally, Mr. Klingshirn emphasized that domestic and foreign relief are addressed by different organizations. The two do not generally mix.

Charles Setchell

The HASS team interviewed Mr. Setchell on March 25, 2011. His perspective was very different from Mr. Klingshirn's. Mr. Setchell described two approaches to disaster relief shelters: one, which he called the deployment approach, provides a complete package solution that needs to be transported to the disaster site. The second approach, which he called the context-driven approach, seeks to use material and labor on the ground to design a shelter solution specific to each disaster scenario. The first approach is more expensive and less flexible. The second approach has the benefit of inserting money into the local economy, but cannot be built in advance of the disaster.

Mr. Setchell's organization prefers the context-driven approach, and they are able to fill approximately twenty-five percent of the need in relief efforts in which they are involved with this approach. (Since the HASS team is working on a shelter system to be built in advance of a disaster, the HASS team used the deployment approach.)

Costs are usually around $1200 to $1300 per family, but varies greatly.

Power is generally not available. Water and waste are dealt with on a community basis. Water purification is not generally an issue after thirty to sixty days. Cooking is typically performed on a three-stone fire outside the shelter.

Finally, Mr. Setchell indicated that shelter protections should consider that there is often a high level of gender-based violence in camps.

Matt Myrick and Renee Van Slate

The HASS team interviewed Mr. Myrick and Ms. Van Slate together on April 21, 2011. Ms. Van Slate was introduced to us by Mr. Myrick. New insights learned from them included

cultural issues such as whether the new shelter was better than pre-disaster housing, and how to decide to whom shelter is provided. Also, those seeking to help with relief efforts should adopt a "do no harm" philosophy, considering such issues as whether one is taking jobs from local builders, or whether one is making the host nation seem incapable of dealing with the disaster on their own.

Ms. Van Slate stated that for solutions to be real, they need to be sustainable, and that short term fixes are always detrimental to the local economy. Both stakeholders emphasized the importance of using locally available materials.

Mr. Myrick and Ms. Van Slate emphasized the stark differences from one disaster scenario to another. Often, OFDA is gone within six months of the event. However, disaster relief efforts are ongoing in Haiti four years later. In Japan, money is needed more than shelter.

Analysis

The Stakeholder interviews revealed varied capabilities required if the HASS. Some of the capabilities are in conflict with one another demonstrating the flexibility required of this system. Each had differing viewpoints about the number of people that would need to be housed, which basic services the shelter would provide, and what infrastructure would be available in the shelter community. Some argued for an ideal (such as the context-driven approach) with which the HASS team could not help. All gave the HASS team great insight into the complexity of the problem.

Ultimately, three things emerged from these interviews that would guide the HASS project from this point forward:

- The greatest need is in the transitional period between emergency shelter and permanent housing. This lasts from approximately 6 months after the event until 2.5 to 5 years after the event.
- Use of locally available materials is very important because it drives local economy, provides for culturally acceptable customization of the shelter, and increases durability. Because the HASS team designed a shelter in advance of any actual disaster, the team needed to build in flexibility to be able to use a variety of materials that might be locally available.

- Various services should be provided for by the shelter system, such as water purification, communication, and food storage and preparation.

2.2 Operational Concept Design

The operational concept for the HASS (also called a concept of operations or CONOPS) was developed based on stakeholder input received over multiple meetings which were held over the length of the project. This stakeholder input allowed the team to realistically envision the problem at hand and determine probable scenarios and issues the HASS and its occupants would encounter during its lifecycle. Significant effort was also expended to ensure the HASS' operational concept fell in line with current stakeholder operational concepts and implementation strategies; this would ensure a smooth and more acceptable future implementation effort.

Background research was also performed on various HA/DR scenarios to determine any outlying issues related to safety, logistics, implementation and operation which could affect the HASS and its occupants.

The use of COTS components and standardized transportation equipment/modes was also heavily researched and integrated into the HASS' CONOPS; as is best practice when rapid prototyping, development, and fielding of equipment is taking place.

2.2.1 System Objectives

The primary objective of the HASS is to shelter reliably its occupants, providing security and privacy through its design. It must be easily transportable and require minimal maintenance. Secondary and tertiary objectives of the system include: capability to cook and store food; capability to purify and store water; minimal sanitation capability (through the capability to create potable water); capability to receive voice communications from the local government; capability to provide artificial lighting. The system should also be scalable (size-wise) and be capable of utilize local materials in its construction.

The HASS is intended to fill the current gap in the 6 month to 3 year shelter capability; deploying 6 months after the disaster event in replacement of emergency shelter kits. The HASS is intended to act as a transitional shelter system and will accommodate disaster victims until

permanent housing is available. If no permanent housing is available, the HASS may be transformed into a more permanent shelter via the use of the shelter's frame and locally available construction materials.

2.2.2 General Implementation Strategy

When a disaster occurs, the US government activates military disaster relief organizations either at the request of the affected local government, or in coordination with the affected local government. At the same time, non-military relief organizations (such as NGOs) are immediately mobilized once approval is granted through their liaison personnel at the affected area. These immediate mobilizations result in emergency shelter kits reaching the disaster sites quickly, usually within 72 hours of the event (Klingshirn, et al. 2011). These emergency shelters are utilized and modified by the users to last as long as possible; however, these emergency shelters are not intended for a lifespan beyond six months (Klingshirn, et al. 2011). The average time to rebuild after a disaster is about 3 years, hence there is a shelter capability gap of 6 months to 3 years.

At or before six months have elapsed following the disaster event (or as soon as the coordinating government/relief agency deems necessary), the HASS is moved from its storage location via standard pallets to the disaster site, or to some intermediate distribution node where further transport awaits.

The palletized system is delivered and assembled on-site by untrained disaster victims or disaster relief personnel. The HASS is then inhabited by the displaced persons with their emergency supplies for a prescribed duration of up to 2.5 years; after which the shelter system may be disassembled and either salvaged by the local population, or modified into some more permanent housing structure. No part of the HASS is deemed recoverable by the stakeholder; the system is thus disposable, or "fire-and-forget".

The HASS will be designed to require minimal Preventive Maintenance Checks and Services (PMCS). The HASS will also be designed to meet a high operational reliability so as to require (achieve) minimal repairs over its operational life cycle. Repairs to critical components will be within the ability of an untrained user with supplied tools, or the component will be designed for easy replacement by the untrained user.

The shelter system will also utilize a deployment- and context- driven design; that is, if the stakeholder desires, they will be able to deploy the HASS without some critical construction components (CCC) (i.e. flooring, wall material) in order to reduce costs. Utilizing such a deployment-and context-driven design may not be feasible for all disaster scenarios. It will be up to the stakeholders to determine if it is a necessary as additional time may be required to repackage or sort the stockpiled HASSs and their components based upon the CCCs that are chosen to be left out. These CCCs will be clearly identified in the immediate post-disaster timeframe (1-3 months) based on those materials the stakeholder deems are locally available or salvageable. The specified CCCs will then be procured or salvaged as directed by the stakeholder, and made available to the HASS user at or near the community site. This not only saves the stakeholder acquisition and transportation costs, but allows more funds to be injected into the local economy, for example if the CCCs are purchased from local suppliers. The local government will also coordinate with the supplying US organization to ensure that the HASS kits intended for their locality are configured (to the maximum extent possible) for that locality's specific operational environment, saving costs associated with the transportation and implementation of unnecessary HASS components or features.

The HASS's general implementation strategy can be graphically viewed in the Operational View diagram (OV-1) below (see Figure 2-1).

Figure 2-1 HASS Operational View (OV-1)

2.2.3 Organizations and Activities

2.2.3.1 Local Governments

Local governments are responsible for notifying disaster relief organizations (such as the US government and NGOs) that aid is needed and would be welcome. They should also specify the type of aid required (shelter, food, water, etc.) and some estimate on quantities required. Local governments should also attempt to identify potentially salvageable materials that may be used as CCCs, as well as define the operational scenario in which the HASS will be deployed (for modifying or configuring the system). Local governments should provide all possible assistance in identifying and preparing a location close to the disaster site for use as a central point for collection and distribution of aid materials. The local government should provide for

the security of the aid supplies before distribution to prevent pilferage. They should also provide security and guide personnel to escort the HASS shipment to its final set-up location. They are responsible for maintaining law and order among their citizens so that aid workers are safe.

2.2.3.2 US Government

The US Government should be receptive to the request for aid from the local government and will provide aid if deemed necessary in a timely manner. Arrangements will then be made for expeditious delivery of the requested aid to the designated off-site distribution center via US Navy ships, DOD owned aircraft, or NGO private transportation methods. Upon delivery of the aid to the disaster site by the US Government, a staging area will be setup at the off-site distribution center by the US Government in conjunction with other participating aid organizations. The US Government will then distribute aid from the off-site distribution center to the disaster victims. Local shipping and distribution may be performed by the US Government if the necessary shipping mediums are in place (roads, trucks, trains, fuel) or this function may be performed by NGOs or the local government. US Government representatives are responsible for the conduct of their employees and other specified US citizens in relationship to respecting the customs and laws of the local population.

2.2.3.3 Off-site Distribution Center

The off-site distribution center is a facility outside the designed disaster area (but closer to the affected area than any US Government facility) which may be used for receipt and onward movement of the HASS and other disaster relief-related supplies. The local government should ensure that the offsite distribution center is secure. They are also responsible for aiding the distribution of relief supplies to the maximum extent possible. This may entail providing to US Government or other relief entities such information as specific areas affected by the disaster, displaced population, supply transport and distribution routes, etc. This may also require that the local government coordinate or provide the means for supply distribution and shelter setup (i.e. trucks, aircraft, government support personnel, etc.). This distribution method has been utilized before, most notably in Haiti, and has been proven to be effective. Issues for this method of distribution include: heavy air traffic, with an inability to land; stockpiling of aid due to an inability to move aid from the off-site distribution center, and possibly security concerns from

the desperate local populous due to the large amount of aid present. Each one of these issues has heuristics/lessons learned associated with it, which with further research, can be used to improve the process for future events.

2.2.3.4 Transportation

The HASS shall be moved from its continental US (CONUS) storage location by designated or desired means (this could include military or civilian transport by ground, air, rail, or some combination thereof) in the most expeditious and economic manner to the designated seaport or airport of embarkation. The shelter system will be transported using standard wooden pallets as this is the most common/versatile means of transportation; multiple systems may be transported within standard ISO shipping containers. The ship or aircraft will transport the HASS to the designated air/sea debarkation point, off-site distribution center, or the disaster site itself (as appropriate). If the system is not delivered to the disaster site, further movement will be required (via ground transportation or helicopter). Regardless of the mode of transportation, the HASS is intended to be delivered as close to the ultimate set-up site as possible.

2.2.3.5 Set-up

The HASS is designed to be easily set-up by untrained personnel using common non-specialized tools and accessories (which are provided with the system). The area on which the system is to be assembled should be relatively level, cleared of obstructions and debris, and preferably on solid soil. The HASS can be transported, transshipped and assembled by a two-person crew.

2.2.4 Interactions and Responsibilities

2.2.4.1 US Government Entities

US Government entities, such as USAID or the US Navy, are responsible for procuring and delivering the HASS to the users' disaster site. The stakeholders should be prepared to assist the users by any means possible to expedite the setup and utilization of the shelter system.

2.2.4.2 Users

The users are the displaced victims of the disaster. Their initial responsibility is to set up the HASS upon receipt. The users are also responsible for providing (or requesting, if desired) any additional supplies or components that might be integrated with the HASS; to include: CCCs (if applicable), food, water, fuel for cooking, or general goods. While residing in the shelter, the user is responsible for maintaining the unit and conducting repairs as needed. When notified that more permanent shelter is available, the HASS users should avail themselves of this improved habitation. Should permanent shelter not become available, the user may convert the HASS into a more permanent type of shelter (if desired).

2.2.5 Constraints Affecting the Systems

Constraints affecting the systems could include:

- The HASS is not intended to be re-used by the US Government entities.
- The HASS components are weight and size limited.
- The HASS has a lifespan (expiration date) when used in a non-permanent configuration.
- The HASS requires inputs such as water, food, possible provisions for cooking, or other items for personal use (linens, sanitary items, etc.) to meet operational requirements.
- The HASS is intended to house no more than 10 adults.
- The HASS has prescribed climatic and environmental conditions in which it can be deployed.
- The HASS is only rated to provide a certain quantity of purified water per day.
- The HASS must be assembled by untrained adults.

2.2.6 Processes for System Initiation and Development

The designers intend for the system to be safe, easy to use, cost-effective and useful in virtually any kind of disaster response environment. The system and its components can be manufactured by any entity which has the ability to obtain and work with the materials specified.

While initial design and manufacture will take place in the US, it is likely that additional development and enhancement of the product will take place outside the US

Initial product development and modification will be accomplished following operational test and evaluation. It is envisioned that further feedback and development will occur once the product has been deployed and used in an actual disaster scenario. The information obtained following real-world system employment will be vital to product development.

2.2.7 Maintenance, Repair and Disposal

The maintenance actions required to support the HASS will be minimal and will require no specialized training or tools to complete. Maintenance actions will consist primarily of preventive maintenance such as cleaning, removing snow loads, securing the structure for high winds or dust, and other such actions associated with operating the HASS in an outdoor environment. All maintenance actions will be completed by the users.

When repair actions are required by the HASS, they will be minimal and will require no specialized training or tools to complete. The shelter system design will also limit substantial repair actions; it is intended that 95%-99% of shelters will complete 2.5 years of operation without a major functional failure (with a lower bound confidence interval of 90%). Major components include coverings, liners, fabrics, structural components, or any other component of the structure which is associated with providing the primary needs of the HASS user (as defined in the Mission Needs Statement [MNS] [see Appendix B]). All repair actions will be performed by the users, or by trained personnel when available.

The responsibility of disposing of the HASS falls on the users or the users' local government. From the stakeholder's perspective, the HASS is an expendable system; it may be disposed of in any municipal waste facility because it will be constructed of non-toxic materials.

2.2.8 HASS Operational Activity Hierarchy Diagram (OV-5)

Figure 2-2 below depicts the HASS' major operational activities in chronological order. According to the MNS, the main activities the HASS must perform are: Deploy, Operate, Protect, Serve, and Use Shelter.

"Deploy" consists of activities associated with the deployment, transport, assembly and scalability of the system. "Operate" refers to activities associated with the utilization of the shelter and its subsystems. "Protect" includes activities associated with safeguarding of the occupants and their possessions within the shelter, contributing to a livable and safe atmosphere. "Serve" refers to activities associated with HASS' provided components. These components are not part of the shelter's physical structure, but are intended for integration with the HASS to provide users with capabilities necessary to their health and survival. "Use Shelter" references activities associated with the utilization and maintenance of the shelter structure itself.

Although it is not considered a stakeholder need, the "Dispose" activity will be performed by the HASS and the system user. From the stakeholder's perspective, the HASS is a disposable (not for reuse) system, but the user or the local government will still be ultimately responsible for its disposal and/or salvage.

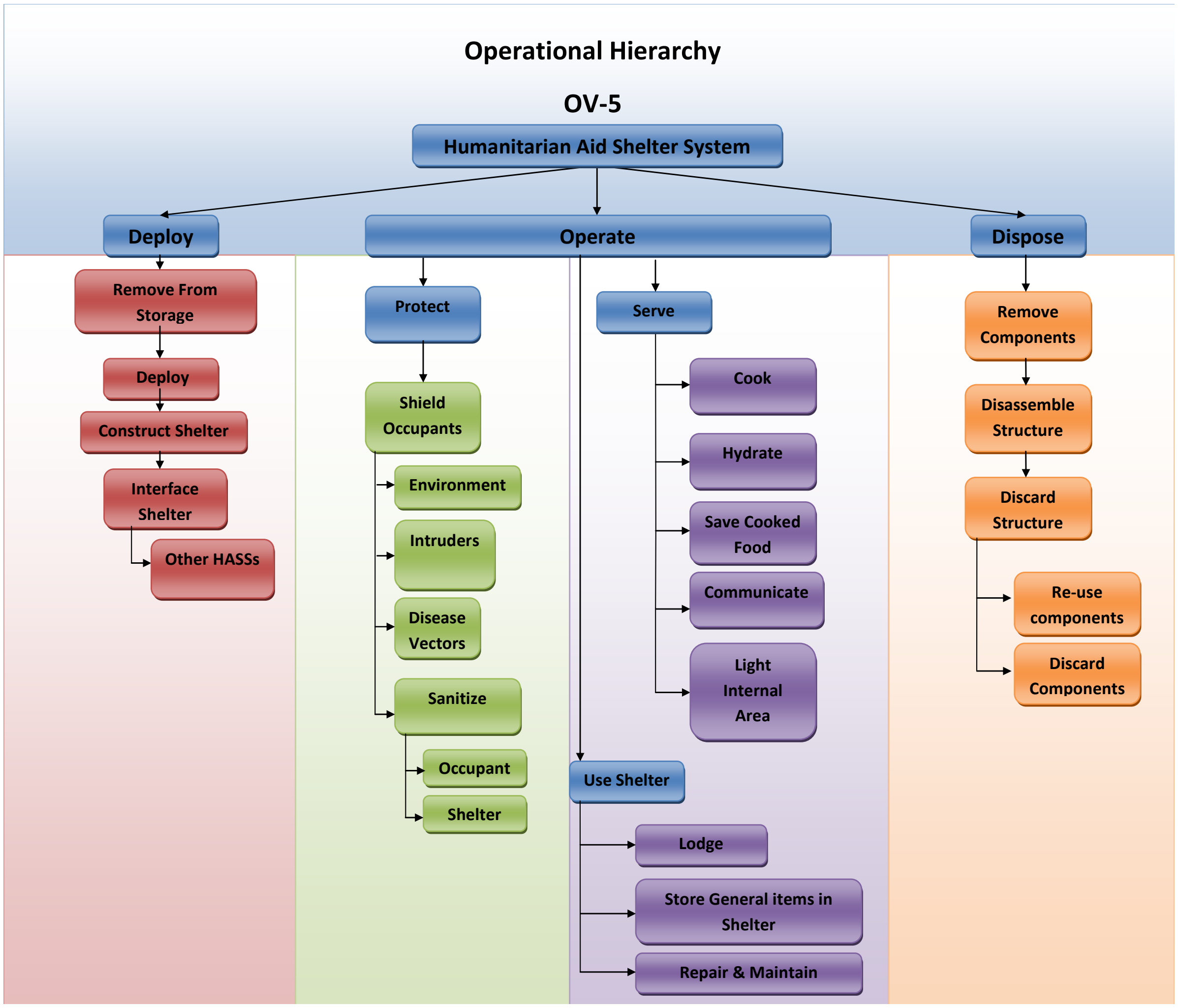


Figure 2-2 HASS Operational Hierarchy Diagram (OV-5)

2.2.9 Operational Environments

While the HASS is intended to operate in a variety of austere environmental conditions, research has been conducted to determine the true environmental conditions in which it is likely to be deployed. The specific environments researched are: tropical, cold weather and desert.

The various physical parameters imposed on the HASS by these environments will be considered in its design, and the system will therefore be designed for (but not limited to) operation in these common environmental conditions.

The specific environments were researched using online weather databases and can be viewed in section 2.2.10 (Weatherbase 2011), (Zoover 2011). This information was extracted from. Challenges posed to the HASS due to each operational environment are also discussed.

2.2.10 Tropical, Cold Weather, and Desert Operational Environments

2.2.10.1 Environmental Type: Tropical

Example Location:	Haiti
Temperature:	70-80 deg F
Humidity:	High (70% average)
Typical Weather:	Sunny (during the May-July wet season, average accumulation is 130 mm per month)
Severe Weather:	Hurricane
Wind:	Mild (average windspeed 10 miles per hour)
Chance of Sun:	50-80%

Operational Environment Challenges posed on shelter:

- High temperatures can cause or accelerate dehydration and food spoilage.
- Periods of heavy rainfall can result in flooding, which can cause disease by washing trash and sewage into living spaces.
- Severe weather (high winds or hurricane) can destroy shelter.

2.2.10.2 Environmental Type: Cold Weather

Example Location:	Northeastern US
Temperature:	-25- 40 deg F
Humidity:	Low (5-40% average)
Typical Weather:	Overcast (Rain accumulation averages 4 inches per month. Snow accumulation is 12 inches per month)
Severe Weather:	Blizzard or Nor'easter (heavy rain or snow often accompanied by high winds)

Wind: Mild (average windspeed 16 miles per hour_

Chance of Sun: 50%

Operational Environment Challenges posed on shelter:

- Cold temperatures can freeze water stored in shelter, and can cause user hypothermia and death.
- High winds and substantial snow loads can damage shelter.
- Snow and rain can cause wet and potentially unsanitary conditions within the shelter. Can cause hypothermia if no heat is provided.
- Blizzard conditions (snow accumulation) can prevent access into and out of shelter.

2.2.10.3 Environmental Type: Desert

Example Location: Middle East (northern Sinai Peninsula, Egypt)

Temperature: 60-100 deg F

Humidity: High (70-80% average)

Typical Weather: Sunny (average rain per month = 0.1 inches)

Severe Weather: Dust storm

Wind: Low (average windspeed 8 miles per hour)

Chance of Sun: 85%

Operational Environment Challenges posed on shelter:

- High solar loads can increase temperature within shelter to levels dangerous to occupants. High temperatures can cause dehydration and food spoilage.
- Dust can create unsanitary conditions and cause breathing difficulties.

2.2.11 Operational Scenarios

The tables below, Table 2-1, Table 2-2, and Table 2-3, illustrate possible operational scenarios that the HASS may encounter. The activities within these scenarios include HASS transportation, setup, logistics, and use.

Table 2-1 Best Case Scenario

Transportation	- Post-disaster request for assistance received - HASS mobilized at storage site, prepared for transport - HASS stakeholder and local government create Offsite Distribution Center - HASS moved from storage site to Offsite Distribution Center - HASS moved from Offsite Distribution Center to disaster site - HASS distributed to users by local government / NGO
Setup	- HASS unpackaged and moved to assembly site - HASS assembled using provided tools (and CCCs if available)
Logistics	- Post-disaster request for assistance transmitted; operating environment and availability of CCC (if necessary) noted for HASS modification - Additional shelter inputs/outputs (water, food, waste disposal)to be provided and managed by NGO or local government - Local government provides security for shelters and transport before/during delivery - Local relief supply distribution point conducts daily resupply and are restocked as necessary
Use	- HASS is used for maximum of 2.5 years (approx 3 years after disaster) - HASS will experience an operational reliability of 99% in reference to its major components. - HASS user will be able to cook food, keep the shelter clean, sanitize, store items, purify water (to an extent), communicate via radio and live comfortably in most environmental conditions - HASS provides a measure of security in that it will protect the users and their belongings from easy theft and intrusion. - Tools and materials necessary for maintenance and repair are provided with the HASS; users perform these measures on their own as necessary

Table 2-2 Normal Case Scenario

Transportation	- Post-disaster request for assistance received - HASS mobilized at storage site, prepared for transport - HASS stakeholder and local government create Offsite Distribution Center - HASS moved from storage site to Offsite Distribution Center - HASS moved from Offsite Distribution Center to disaster site - HASS distributed to users by local government / NGO
Setup	- HASS unpackaged and moved to assembly site - HASS assembled using provided tools (and CCCs if available)
Logistics	- Post-disaster request for assistance transmitted; operating environment and availability of CCC (if necessary) noted for HASS modification - Additional shelter inputs/outputs (water, food, waste disposal)to be provided and managed by NGO or local government - Local government provides security for shelters and transport before/during delivery - Local relief supply distribution point conducts weekly resupply to immediate area; restock and resupply efforts are somewhat disorganized
Use	- HASS is used for maximum of 2.5 years (approx 3 years after disaster) - HASS will experience an operational reliability of 95% in reference to its major components. - HASS user will be able to cook food, keep the shelter clean, sanitize on occasion, store items, purify water (to an extent), communicate via radio and live comfortably in most environmental conditions - HASS provides a measure of security in that it will protect the users and their belongings from easy theft and intrusion. - Tools and materials necessary for maintenance and repair are provided with the HASS; users perform these measures on their own as necessary

Table 2-3 Worst Case Scenario

Transportation	- Post-disaster request for assistance received - HASS mobilized at storage site, prepared for transport - HASS stakeholder and other disaster responders create ad-hoc distribution infrastructure (with minimal interaction from local government) - HASS moved from storage site to ad-hoc distribution site - HASS moved from distribution site to disaster site; certain percentage of units en route pilfered or stolen - HASS distributed to users by disaster responders (transportation delays in-country may extend the deployment timeline to +6 months after disaster event)
Setup	- HASS unpackaged and moved to assembly site - HASS assembled using provided tools (and CCCs if available) - Damage, theft or pilferage of newly arrived systems may result in insufficient materials to construct the HASS, or missing components which limit its capabilities
Logistics	- Post-disaster request for assistance transmitted; operating environment noted for HASS modification - Minimal additional shelter inputs/outputs (water, food, waste disposal) identified or provided by local government/ NGOs - Minimal security provided before/during shelter transport and delivery; theft, damage and pilferage result - Local relief supplies are distributed haphazardly and with little/no organization; theft, pilferage and minimal restocking result
Use	- HASS is used for maximum of 5 years (approx 5.5 years after disaster) - HASS will experience an operational reliability of 95% in reference to its major components (depending on completeness of shelter at time of assembly) - HASS user will be able to cook food, store items, purify water (to an extent) and live adequately in most environmental conditions, if sufficient materials and supplies can be provided for shelter capabilities to be exercised - HASS provides a measure of security in that it will protect the users and their belongings from easy theft and intrusion, if sufficient materials and supplies are available at time of assembly. - Tools and materials necessary for maintenance and repair may be available with the HASS; users unlikely to perform these measures on their own

2.3 Requirements Summary

Operational requirements for the HASS were initially generated by the stakeholders in order to address the capability gap seen in the MNS (See Appendix B). Given the basic requirements from the stakeholders, the project team translated the broad statements from the stakeholders into a more refined system-specific set of requirements. From this translation, numerous types of requirements were generated and documented into the System Specification (See Appendix D). Functional, Non-functional, Performance, and Design Requirements were derived from the Mission Need Statement and published in the System Specification. A systems engineering software tool named "CORE" was utilized to ensure traceability from the Mission Needs Statement to the System Specification.

2.3.1 Operational Requirements

As stated above, operational requirements for the HASS were generated utilizing the broad statements from the Stakeholders through questionnaires and interviews. The primary needs identified by the stakeholders were translated into the Mission Need Statement and are as listed in Table 2-4.

Table 2-4 Operational Requirements

Operational Requirements	**Description**
Operational Environment	Capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes
Operational Lifecycle	Survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed
Transportability Needs	Be transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.
Shelter Capability	Shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective). The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant
Maintainability	Corrective maintenance shall be performed utilizing supplied general purpose tools.

Operational Requirements	Description
Repairability	Designed to require no specialized tools for repairs. All tools required to assemble and make repairs shall be COTS. Tools necessary to perform the required repair tasks shall require no specialized training.
Reliability and Availability	The HASS shall demonstrate a mean time between functional failures of not less than 21,900 hours (2.5 years) for 95% (Threshold) and 99% (Objective) of shelters with a lower bound 90% confidence interval.

2.3.2 Functional requirements

Functional requirements for the HASS explain what has to be done by identifying the necessary task, action or activity that must be accomplished. Functional requirements capture the intended behavior of the HASS and may be expressed as services, tasks or functions the system is required to perform. Some functional requirements accomplished by the HASS are as follows:

- Water Purification Rate. The HASS shall be capable of purifying indigenous fresh water sources at a rate of 5 L/Day per user (Objective).

- Artificial Lighting Performance. Artificial lighting provisions shall be capable of providing 500 LUX to all covered floor space in the HASS in accordance with MIL-STD-1472D: Table XV (Objective).

- Communications. HASS shall incorporate provisions for one-way (Receive) communication which has the ability to produce power for its operation organically (Threshold) and two-way communication (Objective).

2.3.3 Non-functional Requirements

Non-functional requirements for the HASS are requirements that specify criteria that can be used to judge the operation of a system, rather than specific behaviors. Non-Functional requirements impose constraints on the design or implementation (such as performance requirements, security, or reliability). A non-functional requirement for the HASS is as follows:

- Reliability. The HASS shall demonstrate a 95% (T) and 99% (O) reliability over the intended lifecycle (2.5 years) with a lower bound 90% confidence interval.

The derivations of the figures for the reliability and maintainability requirements can be found in Appendix I.

2.3.4 Performance Requirements

The HASS performance requirements are to the extent to which the HASS mission or function must be executed. The requirements are measured in terms of quantity, quality, coverage, timeliness or readiness. During requirements analysis, requirements are interactively developed across all identified functions based on the life cycle of the HASS and characterized in terms of the degree of certainty in their estimate. Some performance requirements for the HASS are as follows:

- Altitude. The HASS shall be capable of transport without degradation at altitudes from 0 to 35,000 feet above sea level. The system shall be operable from 0 to 10,000 feet above sea level. Procedures for high altitude operation (if different than sea level operation) shall be provided.

- Vibration. The HASS shall operate at normal capacity without degradation after exposure to the following vibration profile in accordance with MIL-STD-810 G section 514.6.

RMS Acceleration:1 (Grms):
Vertical - 1.04;
Transverse - 0.20;
Longitudinal - 0.74.

Velocity (in/sec) (peak single amplitude):1
Vertical – 7.61;

Transverse – 1.21;

Longitudinal – 4.59.

Displacement (in) (peak double amplitude):1

Vertical – 0.20

Transverse – 0.02;

Longitudinal – 0.11.

- Operating Terrain. The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized (Objective). The system shall be able to operate on a surface with a 12” slope over the 20’ length (Threshold).

2.3.5 Design Requirements

Design requirements of the HASS are the “build to” constraints that describe specific design that must be incorporated. Design requirements such as interoperability, open systems, and the use of commercial components were documented in the System Specification. Some examples of HASS design requirements are as follows:

- Color. The HASS shall be colored white, Number FS 37925, in accordance FED-STD-595(1994). Exceptions may be made where cultural and political sensitivities are taken into account. For example, in the use of colors used in national or factional flags in accordance with Transitional Shelter Standards Version 10B (2010).

- Scalability and Modularity Interface Size. The HASS shall have an interface that allows adequate clearance for movement, to ingress/egress to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).

- Ventilation Size. Provisions for natural ventilation shall be achieved through an unobstructed aperture with a total area equivalent to .5 m^2.

2.4 Other Requirements or Environmental Constraints

Other requirements and environmental constraints for the HASS are captured below in Figure 2-3. These requirements give a general overview of requirements not yet addressed in the report and the metric associated with each requirement.

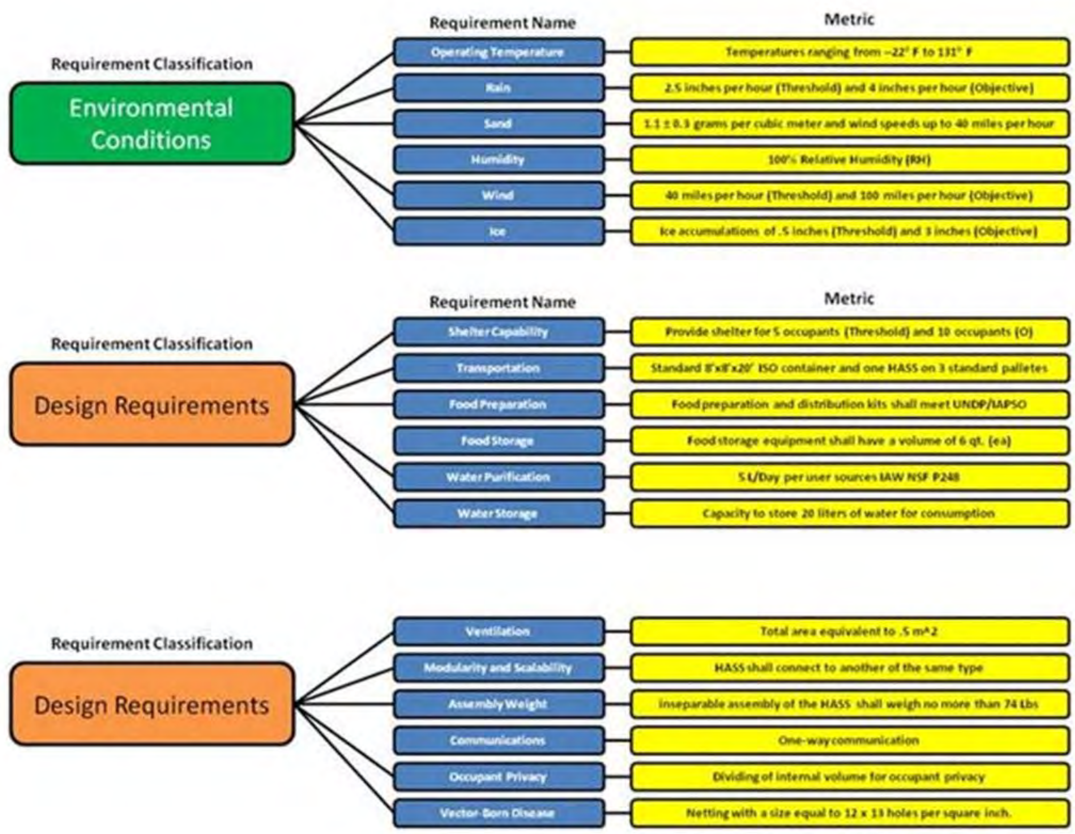


Figure 2-3 Other Requirements and Environmental contraints

2.5 System Functional Description

The system view in Figure 2-4 below depicts the functional hierarchy or SV-4a for the HASS system. The figure has been rolled up to the third level for clarity. A full hierarchy can

be found in Appendix J. The SV-4a depicts the functions of the functional analysis broken down from the highest level functions of Deploy, Operate, and Dispose down to their respective sub functions. Complementary to this system view is the SV-4, which has been depicted as a Functional Flow Block Diagram (FFBD) in Figure 2-5 below. This figure provides the functional flow of the system throughout its lifecycle.

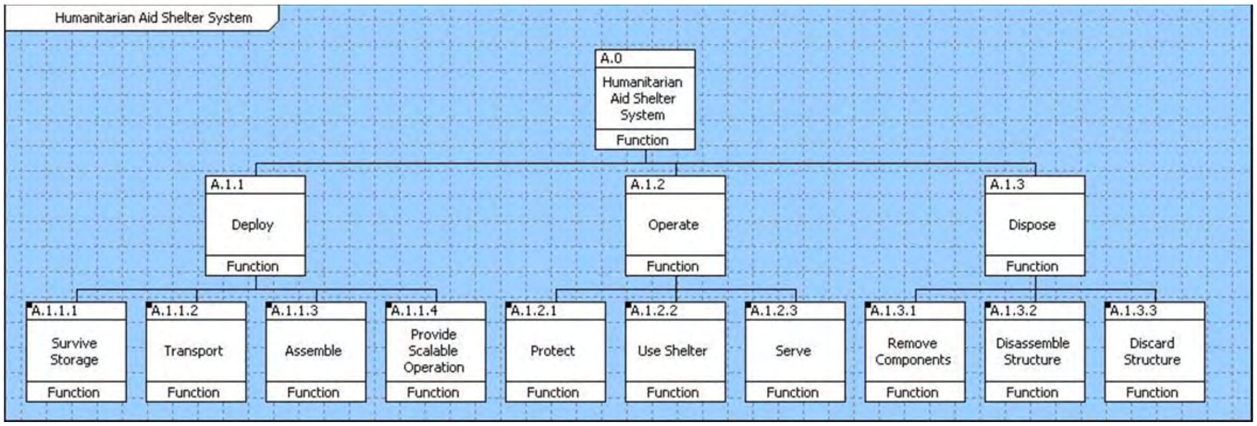


Figure 2-4 SV-4a Functional Hierarchy

2.5.1 SV-4a Functional Hierarchy

2.5.1.1 Deploy

The system begins in a storage phase where it must survive the specified storage conditions, survive loading and shipping to the disaster site and after assembly must be capable of a scaled operation with other HASS systems.

2.5.1.2 Operate

The “Operate” function is broken down into the sub functions of “Protect”, “Use Shelter”, and “Serve”. These are the functions of the shelter once it is deployed (and prior to disposal). It is within this functional level that the bulk of the HASS functions occur. The functions required by the HASS under the “Protect” category include operation in a variety of environments as specified in the MNS. Also included is the protection of the inhabitants from the natural environment as well as the establishment of security and privacy from others in the disaster area. In addition to protection from the elements, the shelter must allot an inhabitant a

space to live and thrive. The interior of the shelter must be functional, providing space for the inhabitants to live, sleep, eat and store general belongings. As a product of the need for the shelter system to facilitate a living environment, the shelter must provide functionality for food preparation and storage, the distribution of water, communications and the ability to light the interior space of the shelter.

2.5.1.3 Dispose

Upon the conclusion of the useful life of the system it must be deconstructed and disposed of. The “Dispose” function is broken into the removal of individual components, disassembly of the physical shelter structure and the actual discarding of the resultant materials. Those discarded components may either be re-used in a permanent shelter environment or discarded as waste.

2.5.2 SV-4 Functional Flow Block Diagram (FFBD)

The purpose of the SV-4 is to represent the logical flow of the system functions throughout the operation of the HASS system. Figure 2-5 below provides a chronological depiction of the functional activities of the system. For example, at the highest level, the system must deploy prior to operation and disposal. Within the Deploy function, the system must be stored, removed from storage and deployed to the intended location. All of those activities are dependent on the activity prior and cannot be done concurrently. Once the system is deployed, it can operate, protect and serve inhabitants concurrently as shown in the FFBD. The diagram below has been abridged for clarity and the full FFBD can be found in Appendix J

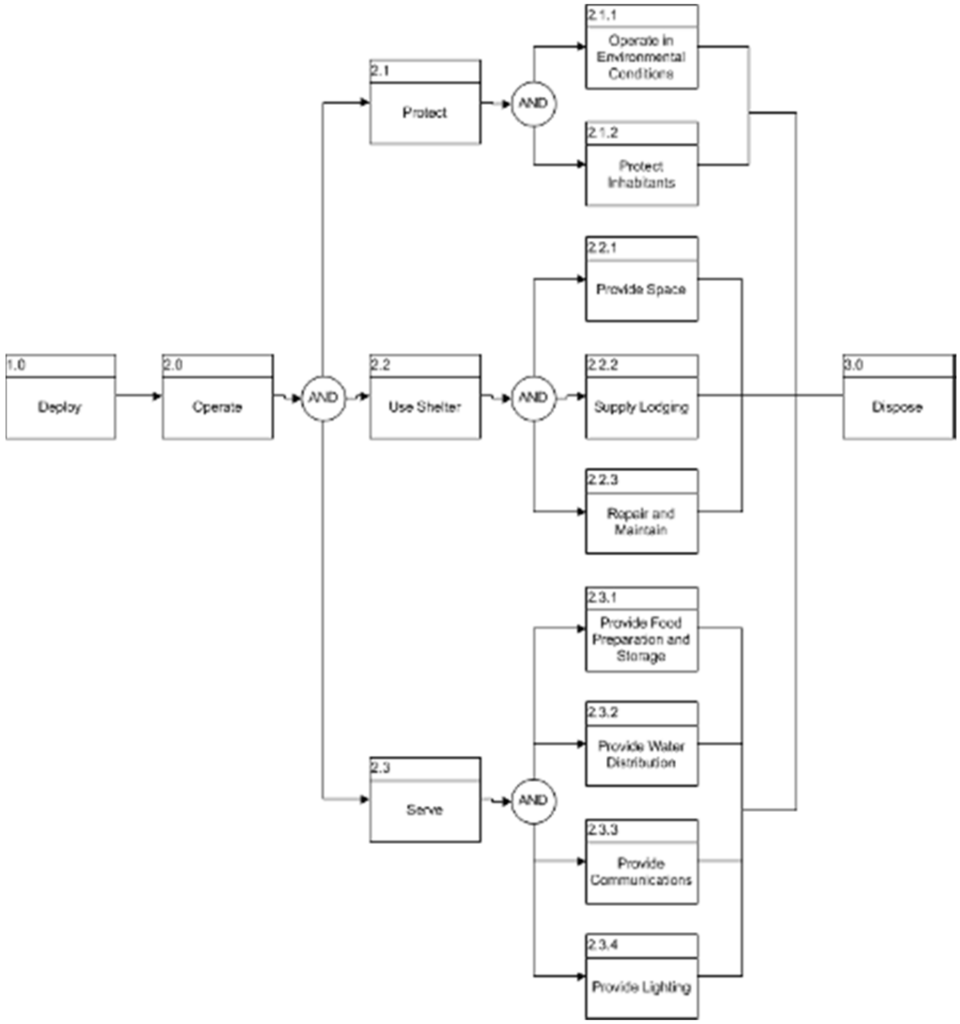


Figure 2-5 SV-4 Functional Flow Block Diagram

2.5.3 IDEF0 Functional Model

The IDEF0 functional model serves to display and manage the inputs and outputs of the various system functions. The HASS IDEF0 was broken down to the third level and provides the functional inputs/outputs of the Deploy, Operate, and Dispose phases of the HASS mission. The first decomposed level of the IDEF0 is shown in Figure 2-6 and provides the material flow for the HASS system. The system begins with the delivery of materials from the vendor and subsequent placement into storage. When needed, the stored HASS systems are mobilized and sent to the disaster area where they are assembled and made ready for occupation. At the end of their useful life, they are disassembled and scrapped. The HASS mission phases are further

broken down in the Figure 2-7 through Figure 2-9. Each phase is decomposed to the next level and the functional inputs/outputs are provided.

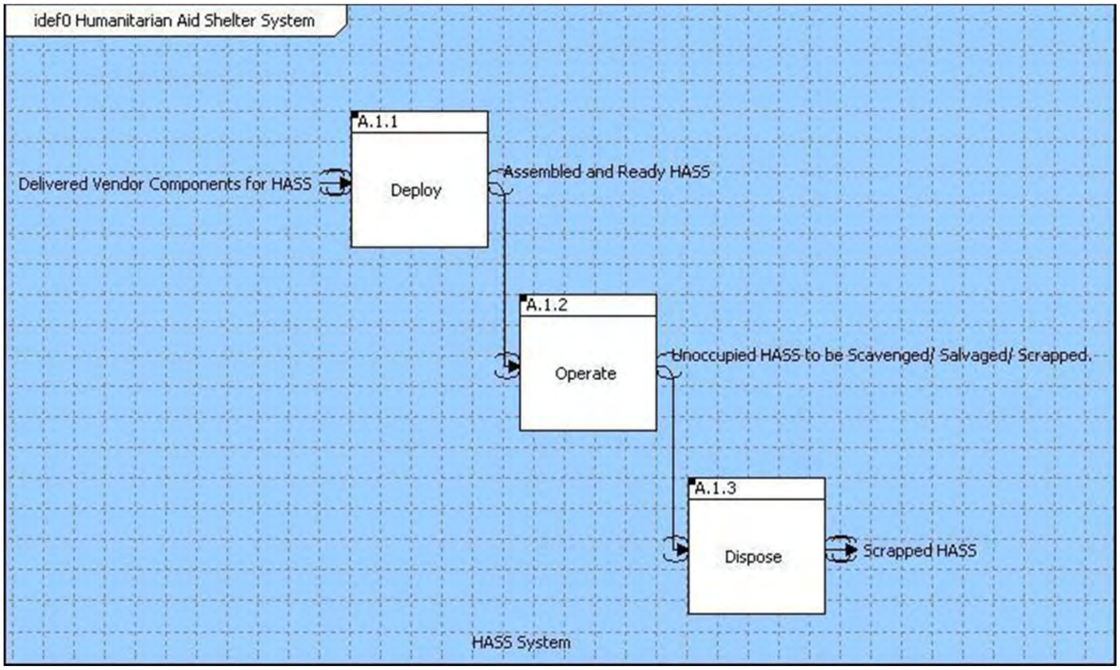


Figure 2-6 A_1 Second Level Decomposition

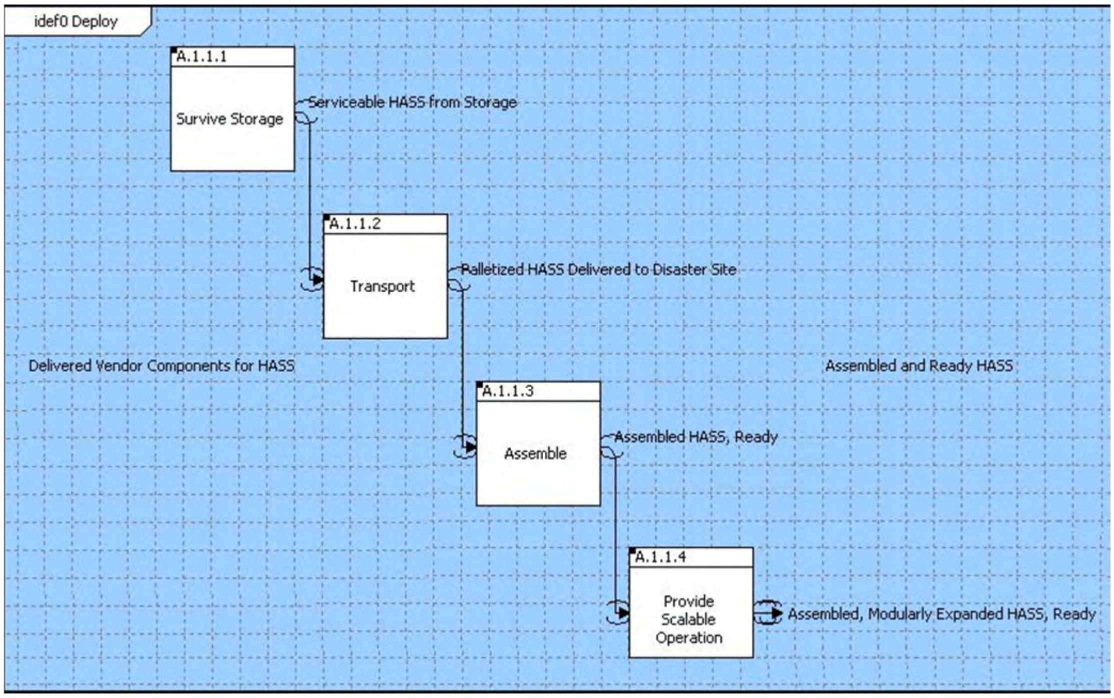


Figure 2-7 $A_{1.1}$ “Deploy” Functional Decomposition

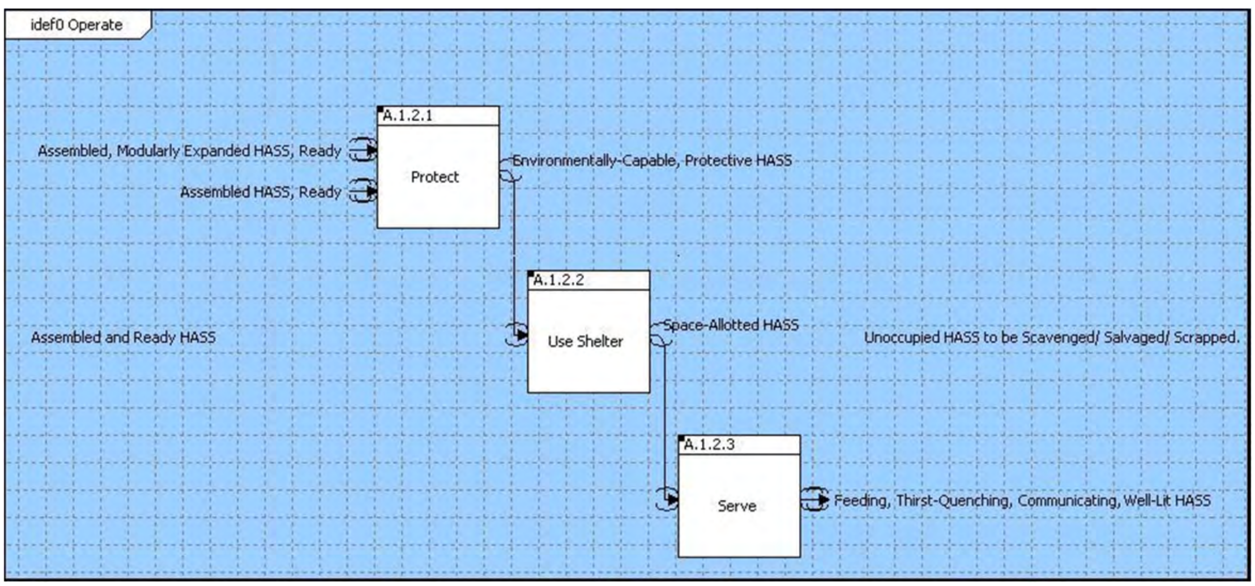


Figure 2-8 A1.2 “Operate” Functional Decomposition

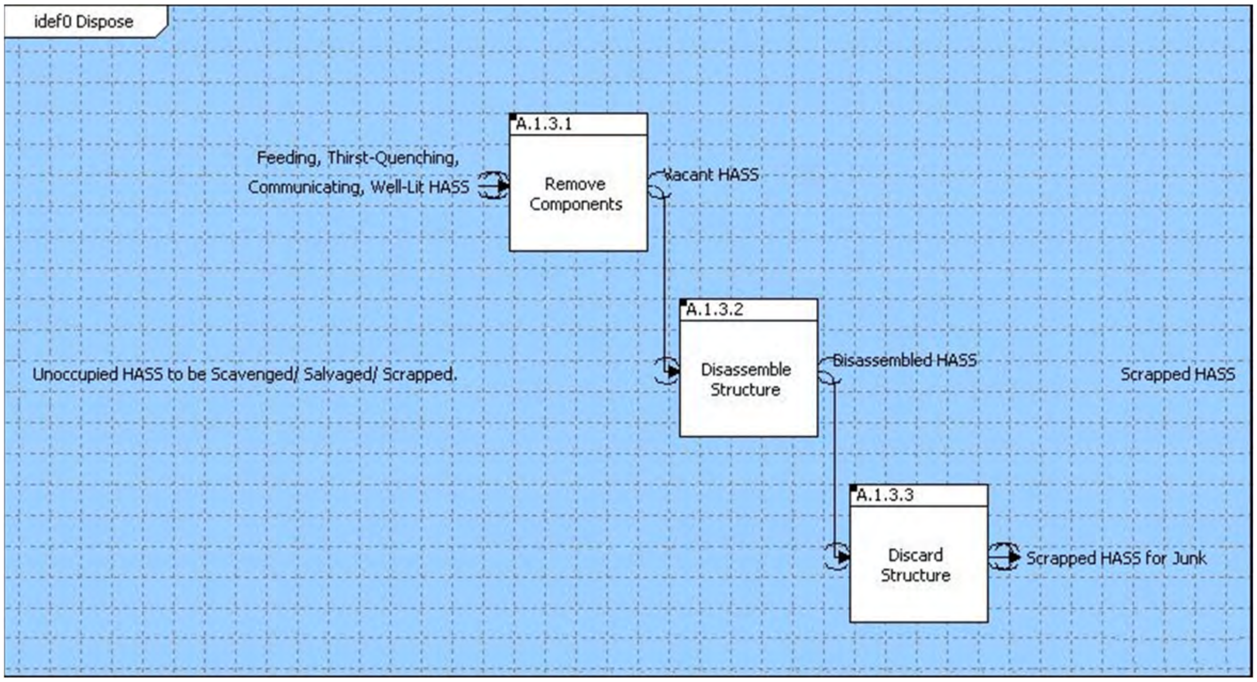


Figure 2-9 $A_{1.3}$ "Dispose" Functional Decomposition

2.5.4 SV-5 Operational Activity to Systems Function Traceability Matrix

The SV-5 serves as a traceability tool to ensure that the Operation Activities contained in the OV-5 are adequately supported by the functions of the system. In Figure 2-10 below, the vertical columns contain the Operational Activities (from the OV-5) and the horizontal rows contain the system functions as described in the Functional Analysis. Each function must directly map to at least one operational activity, or the function is unnecessary for the determined operational scenario for the system. In the development of the HASS system, the operational activities were derived from the Mission Need Statement (MNS). The Functional Analysis was then performed with the OV-5 as a reference to ensure that the functions prescribed for the system to perform were in line with the Operational Activities of the system. The SV-5 was then created to display those relationships and to ensure that there were not any unsupported Operational Activities or unnecessary functions. In the figure below, a dot shows where each function supports a given Operational Activity.

SV-5 Operational Activities to System Functions	1.0 Deploy	1.1 Remove From Storage	1.2 Deploy	1.3 Construct Shelter	1.4 Interface Shelter	1.4.1 Interface to Other HASS	2.0 Operate	2.1 Protect	2.1.1 Shield Occupants	2.1.1.1 Shield from Environment	2.1.1.2 Shield From Intruders	2.1.1.3 Shield From Disease Vectors	2.1.2 Sanitize	2.1.2.1 Sanitize Occupants	2.1.2.2 Sanitize Shelter	2.2 Serve	2.2.1 Cook	2.2.2 Hydrate	2.2.3 Save Cooked Food	2.2.4 Communicate	2.2.5 Light Internal Area	2.3 Use Shelter	2.3.1 Lodge Inhabitants	2.3.2 Store general Items in Shelter	2.3.3 Repair & Maintain	[illegible]	3.1 Remove Components	3.2 Disassemble Structure	3.3 Discard Structure	3.3.1 Re-use Components	3.3.2 Discard Components
1.0 Deploy																															
1.1 Survive Storage																															
1.1.1 Survive in storage conditions		•																													
1.2 Transport																															
1.2.1 Palletize		•																													
1.2.2 Load		•																													
1.2.3 Ship			•																												
1.2.4 Unload			•																												
1.2.5 Carry to assembly site			•																												
1.2.6 Survive transportation			•																												
1.3 Assemble																															
1.3.1 Assemble on previously prepared site				•																											
1.4 Provide Scalable Operation																															
1.4.1 Provide common interfaces					•	•																									
1.4.2 Interface with other HASS						•																									
2.0 Operate																															
2.1 Protect																															
2.1.1 Operate in Environmental Conditions Without Degradation																															
2.1.1.1 Operate in different temperature environments								•	•	•																					
2.1.1.2 Operate in different precipitation conditions								•	•	•																					
2.1.1.3 Operate in different wind conditions								•	•	•																					
2.1.1.4 Operate on various soils and ground conditions								•	•	•																					
2.1.1.5 Operate on uneven grounds								•	•	•																					
2.1.1.6 Operate in sandy/dusty conditions								•	•	•																					
2.1.1.7 Operate in solar radiation								•	•	•																					
2.1.1.8 Operate in salt fog conditions								•	•	•																					
2.1.2 Protect Habitants																															
2.1.2.1 Safeguard from environment								•	•	•																					
2.1.2.1.1 Insulate habitants								•	•	•																					
2.1.2.1.2 Maintain hygenic livable space								•	•				•	•	•																
2.1.2.1.3 Maintain habitable internal temperature								•	•	•																					
2.1.2.1.4 Provide ventilation								•	•	•																					
2.1.2.1.5 Provide vector-free internal volume								•	•			•																			
2.1.2.2 Enable security								•	•		•																				
2.1.2.3 Enable privacy								•	•		•																				
2.2 Use Shelter																															
2.2.1 Provide Space																															
2.2.1.1 Provide space for occupants																						•	•								
2.2.1.2 Provide space for water storage																•		•				•		•							
2.2.1.3 Provide space for food storage																•			•			•		•							
2.2.1.4 Provide general storage space																						•		•							
2.2.2 Supply Lodging																															
2.2.2.1 Allot sleeping provisions																						•	•								
2.2.3 Repair and Maintain																															
2.2.3.1 Perform preventative maintenance																						•			•						
2.2.3.2 Perform corrective maintenance																						•			•						
2.3 Serve																															
2.3.1 Provide Food Preparation, Storage and Distribution																															
2.3.1.1 Cook food																•	•														
2.3.1.2 Distribute prepared food																•	•														
2.3.1.3 Store prepared food																•	•		•			•		•							
2.3.2 Water Purification, Storage and Distribution																															
2.3.2.1 Purify water																•		•													
2.3.2.2 Distribute potable water																•		•													
2.3.2.3 Store potable water																•		•				•		•							
2.3.3 Provide Communications																															
2.3.3.1 Provide communication																•				•											
2.3.3.1.1 Enable inbound communication																•				•											
2.3.3.1.2 Enable outbound communication																•				•											
2.3.4 Provide Lighting																															
2.3.4.1 Provide natural lighting																•					•										
2.3.4.1.1 Provide adjustable natural light																•					•										
2.3.4.2 Provide artifical lighting																•					•										
3.0 Dispose																															
3.1 Remove Components																															
3.1.1 Remove Reusuable components from shelter																											•				
3.2 Disassemble Structure																															
3.2.1 Take shelter structure apart																												•			
3.3 Discard Structure																															
3.3.1 Re-Use components																													•	•	
3.3.2 Discard components																													•		•

Figure 2-10 SV-5 Traceability Matrix

2.6 Technical Measures

Technical Performance Measures (TPMs) for the HASS include Measures of Effectiveness (MOE), Key Performance Parameters (KPP), and Measures of Performance (MOP). These measures are a means of determining the degree to which different aspects of the HASS must comply to meet the capability needs.

The HASS's Mission Need Statement (MNS) (see Appendix B) contains a combination of capabilities, operational requirements and design requirements. The TPMs were established and refined based on a combination of inputs from stakeholders, the HASS Capstone team, and external references (Appendix D, Section 2.0) as depicted in Figure 2-11 below.

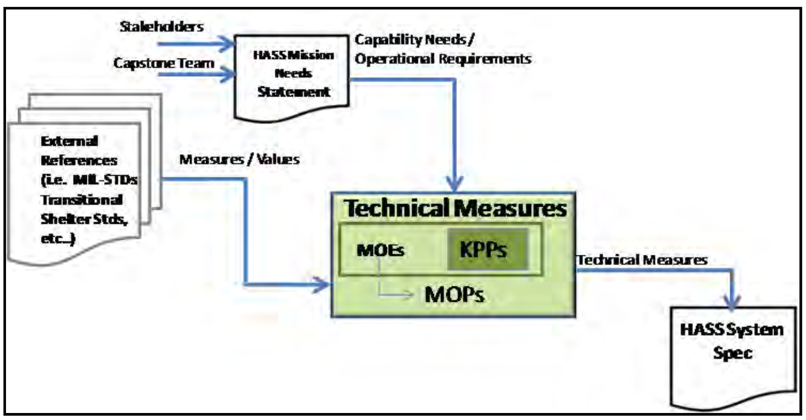


Figure 2-11 Technical Measures development for HASS

The Measures of Performance (MOP) are the detailed measures and values, qualitative and quantitative, used in specifying the system performance requirements, and are included in both the Mission Need Statement and to a larger extent in the System Specification (see Appendix D). The Key Performance Parameters (KPPs) are a subset of TPMs that have been deemed critical to the system's meeting the capability needs described in the MNS, and are provided in Section 2.6.2.

2.6.1 MOE/MOP

The MOPs were developed in concert with the system MNS. As information was collected through stakeholder feedback and design team research, it became necessary to define the requirements in quantifiable terms. The design team analyzed each capability need presented by the stakeholders and researched quantifiable terms to help define those requirements. From this research, MOEs were established for each capability need. Additionally, threshold and objective values were defined which allowed for measureable performance evaluation to be conducted. Table 2-5 below illustrate the Mission Need/Capability, MOEs, and MOPs based on the MNS's primary capabilities and indicates which are Key Performance Parameters (KPPs).

Table 2-5 MOEs and MOPs

Capability Need	Measure of Effectiveness	Measure of Performance			**KPP**
		MOP	Threshold	Objective	
Shelter Capability	Space per occupant	Square meters of living space per occupant	3.5	4.5	•
	Occupants per HASS	Quantity of occupants HASS accommodates	5	10	
Operational Environment	Operate without degradation to any part of structure in <u>rain</u> fall	Inches of rainfall per hour	2.5	4.0	•
	Operate without degradation to any part of structure in <u>snow</u> fall	Pressure of snow load on structure in psi	.0435	.058	
	Operate without degradation to any part of structure in <u>salt fog</u>	% reduction in yield strength in any structural component	10%	5%	
	Operate without degradation to any part of structure in <u>dust</u>	Dust particle size (µm)combined with wind speed in mph	140 µm, 20 mph	-	
	Operate without degradation to any part of structure in <u>ice</u>	Ice accumulation on structure in inches	0.5	3	
	Operate without degradation to any part of structure in <u>high wind</u>	Wind velocity - mph	40	100	
	Operate without degradation to any part of structure in <u>sand</u>	Sand concentration (g / ft^3) combined with particle size (µm)and wind speed (mph)	0.033 ± 0.0075 g perft3 , 150-850 µm, 40 mph		
	Operate without degradation to any part of structure in <u>temperature extremes</u>	Temperature range in degrees Fahrenheit	-22 to 131	-22 to 144	
Transportability	transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.	Quantity of Standard pallets (48"x45"x5") required per HASS	3	1	•

Operational Life Cycle	Survive Operational Life Cycle	Operational usage in Years	2.5	5	•
Reliability	Reliability of the HASS	Probability of mean time between functional failures of not less than 21,900 hours (2.5 years)	.95	.99	•
Reparability	All HASS tools are COTs	Percentage of tools required to maintain and assemble HASS that are COTs	100%	-	•

2.6.2 KPPs

The KPPs in Table 2-6 below were selected from the population of Technical Performance Measures based on iterative discussions within the HASS team, supported by stakeholders and academic advisers.

Table 2-6 HASS Key Performance Parameters

Capability Need	Key Performance Parameter (KPP)	Measure of Performance	Threshold	Objective
Shelter Capability	Space per occupant	Square feet of living space per occupant	37.67	48.44
Operational Environment	Operate without degradation to any part of structure in rain fall	Inches of rainfall per hour	2.5	4.0
Transportability	transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.	Quantity of Standard pallets (48"x45"x5") required per HASS	3	1
Operational Life Cycle	Survive Operational Life Cycle	Operational usage in Years	2.5	5
Reliability	Reliability of the HASS	Probability of mean time between functional failures of not less than 21,900 hours (2.5 years)	.95	.99
Reparability	All HASS tools are COTs	Percentage of tools required to maintain and assemble HASS that are COTs	100%	-
Operating Terrain	Minimum slope for operation	change in terrain height (ft) / change in horizontal distance (ft)	1 ' / 20'	-
	Affordability	US Dollars (2011)	$2300	$500

In Table 2-6 above, each KPP is listed with its capability need, MOP, and threshold and objective values. The threshold values represent the minimal level of performance the HASS must achieve; the objective values, the desired levels of performance.

The “space per occupant” KPP is critical because this is the recognized minimal amount of living space an individual needs to be capable of supporting their health and wellbeing, and of performing basic indoor functions. The threshold and objective values for the HASS are consistent with Sphere Project’s Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response (Sphere Project 2011) and the United Nations High Commissioner for Refugees Handbook for Emergencies 2nd Edition. (UN High Commissioner for Refugees 2011)

The “operate without degradation to any part of structure in rainfall” KPP was developed in response to the need for a shelter to operate and protect occupants in various environmental conditions. Rain was selected out of a variety of environmental conditions (including snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes) because rain was felt to be the most likely/damaging condition the HASS will encounter during its operational usage.

Transportation of the systems for deployment was deemed critical for meeting logistics and support requirements, and overall mission requirements. This stems from the need for the shelter solution to be capable of movement via standard military transportation methods (including air, rail, marine and ground transport) utilizing a standard pallet (defined as a pallet measuring 48” x 45” x 5”). The intent is that a packaged, palletized HASS be able to interface with standard material handling equipment, transportation containers and storage facilities (commercial or military).

The operational life cycle of the HASS was selected as a KPP based on the premise that if the system is unable to perform its basic functions during the expected operational duration then the system fails to meet capability gap and mission needs. “Operational duration” for the system is defined as any time outside of shelf time. The threshold value is based on the identified capability gap in shelter systems from six months to three years after the disaster (which equates to 2.5 years).

Reliability may also be labeled as a measure of suitability; it specifies the level of performance of the HASS with respect to functional failures. The reliability of the system has direct implications on the level of maintenance (both preventative and corrective) required during its lifecycle. The measure of performance is defined as the probability of mean time between essential functional failures of not less than 21,914 hours (2.5 years).

The ability to repair and assemble the HASS using tools that are available as COTS is critical to the system's being deployed and maintained. Requiring the use of any specialized tools for the HASS may prove problematic in many potential deployment locales due to chronic non-availability of tools or lack of familiarity with their use by the end users. The use of specialized tools increases training requirements for the end users, thus adding complexity. The defined measure of performance is the percentage of tools required to maintain and assemble the HASS that are COTS; the threshold value is set at 100%.

The ability of the system to operate on various grades of terrain is considered critical to operational success of the HASS. The KPP is the minimum slope of operation; that is, the minimum grade of terrain the system is capable of operating on. It is unlikely that all deployment sites have a zero grade, or that equipment is available to perform leveling in all situations. The minimum slope the HASS shall be capable of operating is one foot of rise in terrain over 20' horizontally, which equates to a 5% grade in terrain.

Affordability, although not a technical measure, was selected as Key Performance Parameter by the Capstone team to drive decisions with respect to cost. Cost directly impacts the quantity of transitional shelters that is procured and deployed to affected victims of disaster. In terms of cost, the associated cost threshold and objectives is based on both initial procurement costs and transportation cost. The cost threshold of $2300.00 per unit is based on the lower range of actual costs incurred for Haiti transitional shelters surveyed by the Inter-Agency Standing Committee (IASC) Haiti Shelter Cluster. (Naidoo and Pontangaroa n.d.) The HASS prototype procured and tested for this project represents the most capable of the alternatives reviewed and is in excess of the $2300 per unit threshold. However, impacts of economies of scale associated with quantity purchases have not been evaluated which could drive costs lower from the selected prototype's estimated cost. Although the most capable model selected failed to meet the cost threshold without consideration for economies of scale, less capable solutions were identified that meet the threshold requirements and meet the cost threshold of $2300 per unit.

2.7 ANALYTICAL HIERARCHY PROCESS

The Analytical Hierarchy Process (AHP) is a method of analyzing information to determine relative importance between objectives, requirements, etc., from stakeholders and decision makers. Stakeholders were provided a Microsoft Excel-based tool for comparing the HASS' Top Level System Requirements (TLSRS) using pairwise comparisons. In the absence of responses from the stakeholders, the academic advisors provided input for the AHP. Figure 2-12 below illustrates the scale used to elicit feedback from stakeholders on Top Level System Requirements. The scale provides a subjective means of comparing two items at time (pairwise) in effort to measure overall relative importance of multiple items.

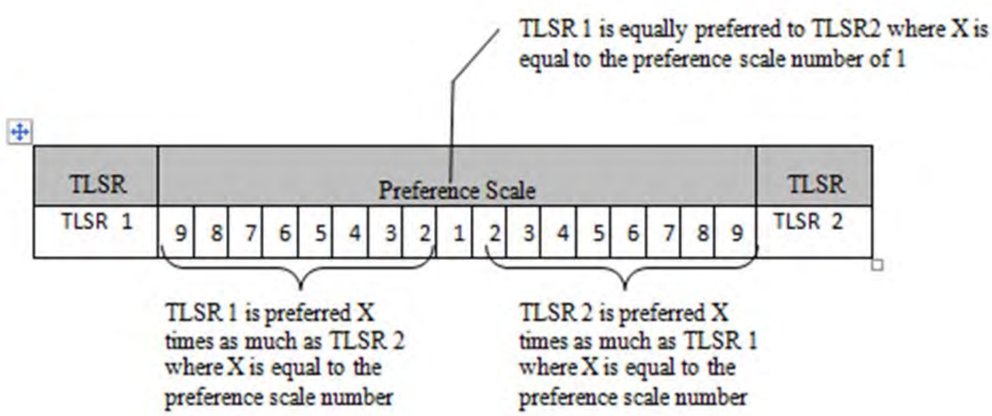


Figure 2-12 HASS Preference Scale for Pairwise Comparisons

Figure 2-12 illustrates that preference scale numbers from 9 to 2 indicate preference of the TLSR 1, a preference scale number of 1 indicates both TLSRs are equally preferable, and the preference scale numbers from 2 to 9 indicate a preference for TLSR 2. The pairwise comparison was performed for all combinations of the Top Level System Requirements. The following Top Level System Requirements were derived from the HASS's Mission Need Statement, compared to one another, and the results from the AHP matrix are included in bar graph in Figure 2-13 below. The weights and respective bars indicate the relative level of importance based on the pairwise comparisons performed

Criteria		Weights
The shelter solution shall be capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes.	1	0.09
The HASS system shall survive an operational usage for a minimum of 2.5 years.	2	0.08
The shelter solution shall be able to be transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.	3	0.17
The HASS shall provide shelter for 5 - 10 occupants.	4	0.24
HASS shall be able to be constructed by untrained personnel with the supplied tools.	5	0.06
The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95% (threshold) and 99% (objective) of shelters with a lower bound 90% confidence interval.	6	0.09
The HASS shall be capable of operations in various terrain environments.	7	0.15
The HASS shall be Affordable	8	0.13
Total Weight		1.00

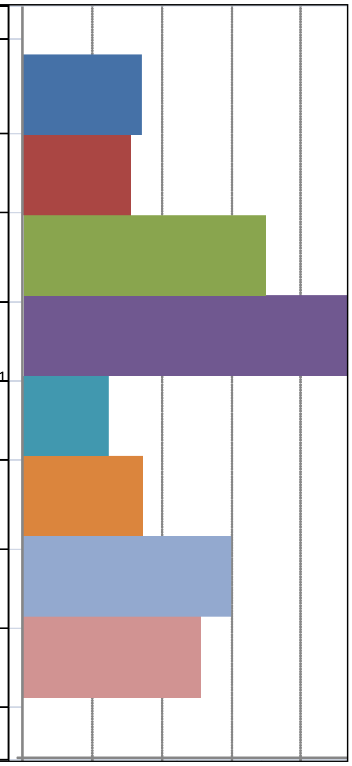


Figure 2-13 TLSR's results from HASS's AHP

Figure 2-13 suggests that the order of precedence of TLSRs among those compared is as follows:

1. The HASS shall provide shelter for 5-10 occupants
2. The shelter solution shall be able to be transported on standard military transportation including air, rail, ship, and ground transportation on a standard pallet
3. The HASS shall be capable of operations in various terrain environments
4. The HASS shall be affordable
5. The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95%(threshold) and 99%(objective) of shelters with a lower bound 90% confidence interval.

6. The shelter solution shall be capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes.
7. The HASS system shall survive an operational usage for a minimum of 2.5 years.
8. HASS shall be able to be constructed by untrained personnel with the supplied tools.

The results from the AHP initiates the processes for traceability between what the stakeholders perceive as important and how well the design solution satisfies those preferences. The AHP and associated weights are inputs into the Quality Functional Deployment process as described in Section 3.4 below. The principles of AHP were derived from lessons learned through the Master of Science in Systems Engineering (MSSE) program at NPS. Initial demonstration of this principle was provided by Professor Brigitte Kwinn as part of SE3100, Fundamentals of Systems Engineering course (Kwinn 2009).

3. Functional Analysis and Allocation

A functional analysis IPT was established early in the HASS program to decompose the functions down to an appropriate level. This was to determine if a new or an existing design was required to a level at which the design team could establish a specific design to requirements as an input. A breakdown of functions into sub-functions was illustrated in order to describe major subsystems. The functional analysis describes the "whats" of the HASS subsystems.

The allocation of the functions determines the "hows" of the subsystems. The allocation allowed for the generation of a functional hierarchy (SV-4). The SV-4 was evaluated to determine what mechanisms and resources were required to accomplish the function (i.e. equipment, software, people, facilities or various combinations thereof).

3.1 Functional Analysis

The HASS Mission Needs Statement (MNS) (see Appendix B) was utilized to decompose the system into its major functions. Three major functions were identified using the MNS: "Deploy," "Operate," and "Dispose". "Operate" was further defined into the functions of "Protect" (the occupants), "Use" (the shelter) and "Serve" (the occupants). These six major functions were further broken down into sub functions.

The function "Deploy" was determined to contain four sub functions: the HASS system must *survive storage*, must *be able to transport*, must *be able to be assembled* and must *be scalable*. The function "Protect" was comprised of two sub functions: the HASS must operate *under specified environmental conditions without any degradation*, and must *protect all of the habitants*. The function "Using the Shelter" incorporated *supply lodging for the habitants* and *provides space for the habitants and their identified essential needs*.

"Serve" encompassed many capabilities, the most important of which is *provide a means to provide food preparation and storage*. Additionally the HASS must *provide water distribution*, *communication* and *lighting*. The final function "Dispose" encompasses sub functions *component removal*, *disassembly of the structure* and the *ability to discard the structure*.

All sub functions described herein were further decomposed, the details of which can be seen in Table 3-1 below.

Table 3-1 Functional Analysis

1.0	**Deploy**
1.1	**Survive Storage**
1.1.1	Survive in storage conditions
1.2	**Transport**
1.2.1	Palletize
1.2.2	Load
1.2.3	Ship
1.2.4	Unload
1.2.5	Carry to assembly site
1.2.6	Survive transportation
1.3	**Assemble**
1.3.1	Assemble on previously prepared site
1.4	**Provide Scalable operation**
1.4.1	Provide common interfaces
1.4.2	Interface with other HASS
2.0	**Operate**
2.1	**Protect**
2.1.1	**Operate in Environmental Conditions Without Degradation**
2.1.1.1	Operate in different temperature environments
2.1.1.2	Operate in different precipitation conditions
2.1.1.3	Operate in different wind conditions
2.1.1.4	Operate on various soils and ground conditions
2.1.1.5	Operate on uneven grounds
2.1.1.6	Operate in sandy/dusty conditions
2.1.1.7	Operate in solar radiation

2.1.1.8	Operate in salt fog conditions
2.1.2	**Protect Habitants**
2.1.2.1	Safeguard from environment
2.1.2.1.1	Insulate habitants
2.1.2.1.2	Maintain hygienic livable space
2.1.2.1.3	Maintain habitable internal temperature
2.1.2.1.4	Provide ventilation
2.1.2.1.5	Provide vector-free internal volume
2.1.2.2	Enable security
2.1.2.3	Enable privacy
2.2	**Use Shelter**
2.2.1	**Provide Space**
2.2.1.1	Provide space for occupants
2.2.1.2	Provide space for water storage
2.2.1.3	Provide space for food storage
2.2.1.4	Provide general storage space
2.2.2	**Supply Lodging**
2.2.2.1	Allot sleeping provisions
2.3	**Serve**
2.3.1	**Provide Food Preparation and Storage**
2.3.1.1	Cook food
2.3.1.2	Distribute prepared food
2.3.1.3	Store prepared food
2.3.2	**Provide Water Distribution**
2.3.2.1	Process water
2.3.2.2	Distribute potable water
2.3.2.3	Store potable water
2.3.3	**Provide Communications**
2.3.3.1	Provide communication

2.3.3.1.1	Enable inbound communication
2.3.3.1.2	Enable outbound communication
2.3.4	**Provide Lighting**
2.3.4.1	Provide natural lighting
2.3.4.1.1	Provide adjustable natural light
2.3.4.2	Provide artificial lighting
3.0	**Dispose**
3.1	**Remove Components**
3.1.1	Remove reusable components from shelter
3.2	**Disassemble Structure**
3.2.1	Take shelter structure apart
3.3	**Discard Structure**
3.3.1	Re-Use components
3.3.2	Discard components

3.2 Allocation

The team performed extensive analysis of requirements in the Mission Needs Statement and the System Specification resulting in traceability using the CORE Spectrum 7.0 (SP 6) product. The version of the CORE product used was the “full blown” one, as the University Edition was too constrained to support the magnitude of the capstone project need.

The source requirements documents that provided input for the analysis are included as Appendix B, Mission Needs Statement and Appendix D, System Specification. “Shall” statements of both sources were “shredded” in CORE to the “atomic” level to convey unique, unambiguous, verifiable constraint or performance requirements, along with rationale to justify their statement or derivation. The team performed analysis of the shredded requirements to ensure identified permutations of complexly-stated MNS and System Specification requirements were intended. Permutations found not to be intended were discarded, as documented in the Rationale Column in Appendix M, HASS Mission Needs Statement and HASS System Specification Requirements Export from CORE. Next, the team established rigorous traceability

relationships to ensure that all MNS requirements were addressed in the System Specification and to ensure that no unintended expansion of requirements was permitted in the System Specification.

The team also documented the HASS Functional Analysis in CORE as discussed separately in Section 3.1. The functional hierarchy was placed in CORE with inputs/outputs necessary to illustrate the operational lifecycle of the HASS System. Then, the functional analysis was traced into the System Specification at the two highest levels to ensure that System Specification requirements were sufficiently complete to meet the perceived functional needs.

As the result of performing both the MNS to System Specification and Functional Analysis to System Specification traceability analyses, the team identified a number of issues. Most findings regarded unintended requirements permutations or missing /ambiguous trace relationships (involving the inability to readily link MNS Parent and System Specification Child requirements or the inability to readily link HASS System Functions with System Specification requirements). The team addressed most issues through ongoing, direct collaboration. Twenty-five issues, though, are documented in CORE as captured in Appendix K, Requirements & Functional Issues CORE Export. The Team resolved all but two documented issues as indicated in Appendix K, CORE- Documented HASS Requirements and Functional Issues. The two remaining Open Issues require a follow-on stage of analysis and design to be accomplished by another Capstone Team.

A summary of HASS CORE Requirements metrics is in the below Figure 3-1. As illustrated in Figure 3-1, the team developed 329 Requirements objects to address the MNS and System Specification. The objects serve to support three purposes: (1) documenting the "shredded" atomic-level, verifiable requirements at the MNS and System Specification levels, (2) organizing the requirements, and, (3) setting the stage for the work of a follow-on capstone team.

Several other types of CORE Objects support the documentation of the MNS and System Specification requirements. As shown Figure 3-1, the team identified two "Document" objects to identify the traced sources of all requirements. Next, the team defined twenty-two terms used between the two requirements documents in "DefinedTerm" objects. Next, two "ExternalFile" objects provide access to contents of a figure and a table used in the HASS System Specification

(available in this report as enclosed in Appendix D, System Specification). Next, the single "Component" object permits traceability to the physical "HASS System" entity. NOTE: The Team did not populate subordinate components to the "HASS System" component, demarking the hand-off point in requirements for a follow-on Capstone Team.

Next, the team populated 68 "Function" objects to capture the HASS Functional Hierarchy down to the sixth level in some cases. And, finally, the 14 "Item" objects constitute inputs and outputs of functions, as illustrated in the IDEF0 artifacts elsewhere in the Capstone Report.

The team established traceability relationships within CORE to perform the necessary analysis as shown in Figure 3-2.

To support review of HASS CORE contents, the team provides access to the source CORE file and a number of extracts in the following appendices: (1) Appendix K, Requirements and Functional Issues CORE Export; (2) Appendix L, CORE Database File; (3) Appendix M, MNS & System Requirements CORE Export; and (4) Appendix N, MNS & System Requirements Defined Terms CORE Export.

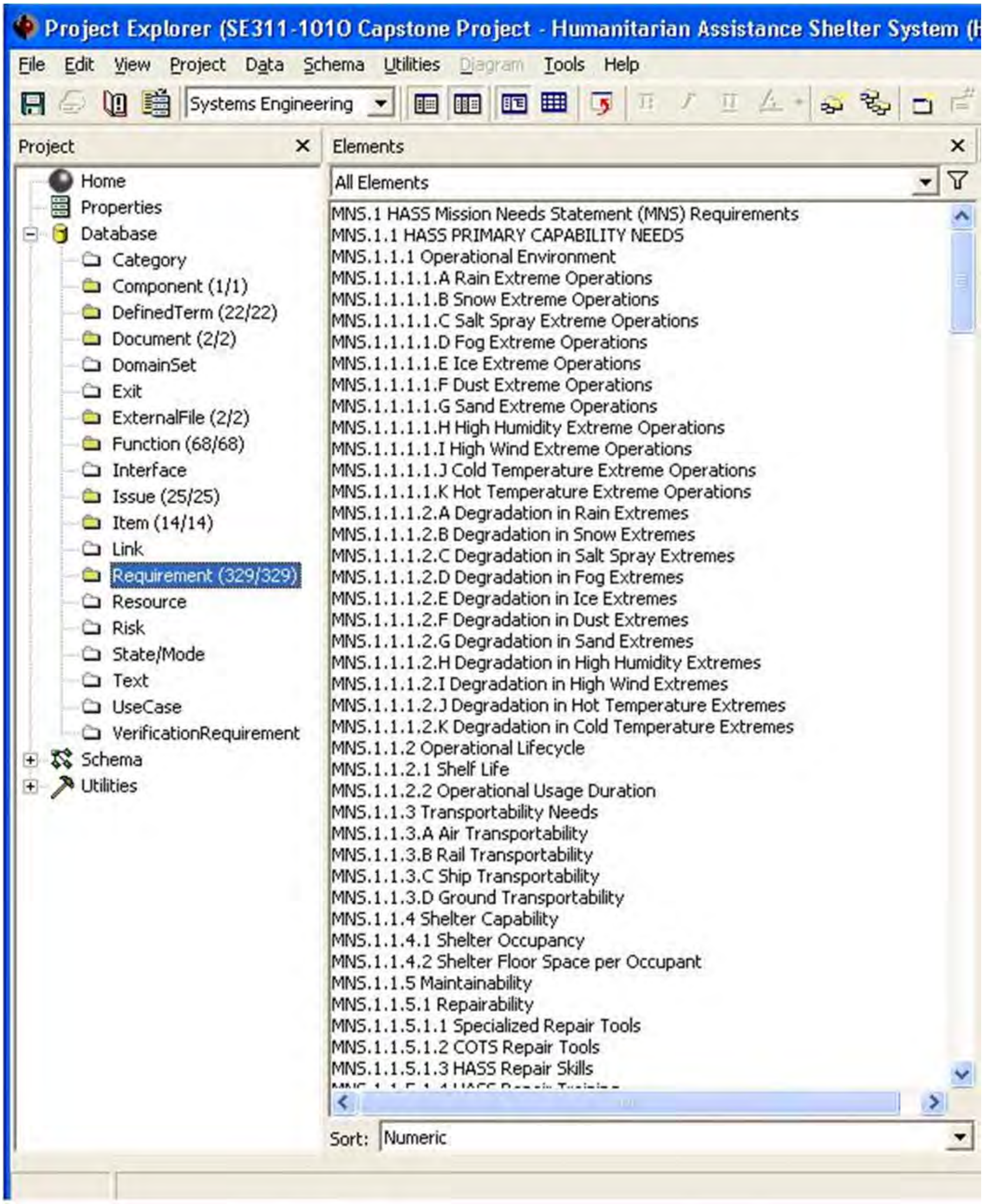


Figure 3-1 HASS CORE Project Database Summary View

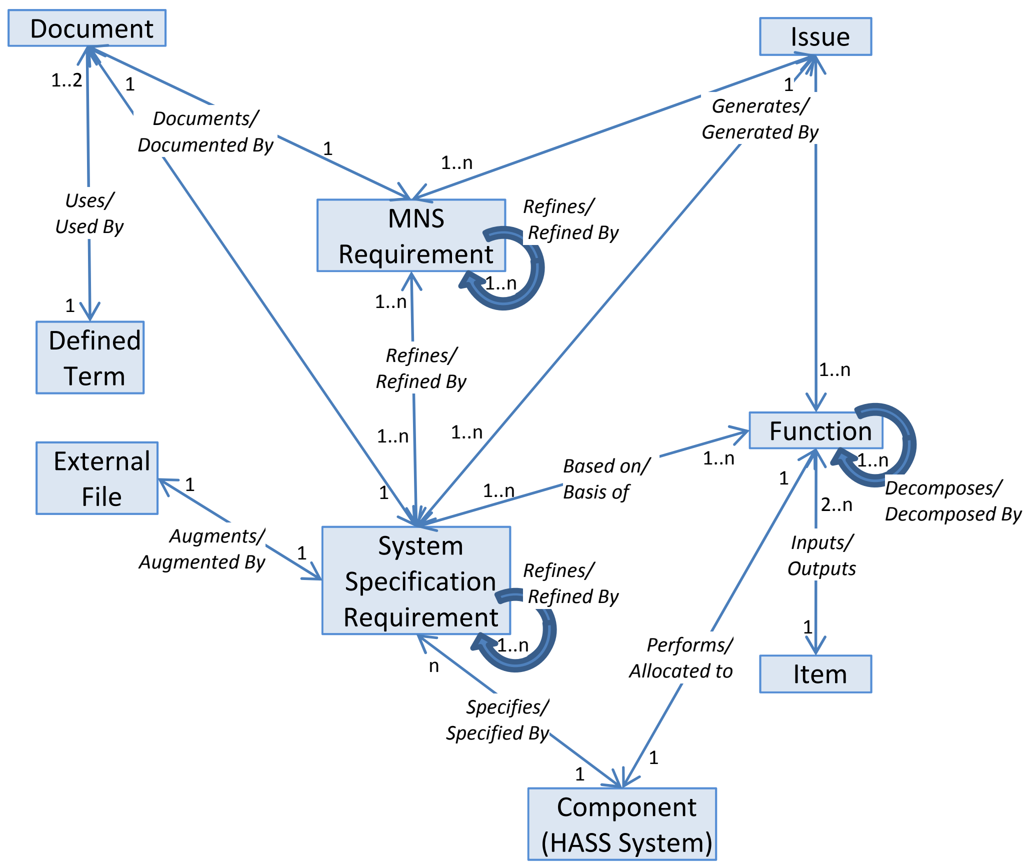


Figure 3-2 HASS Requirement and Function Trace Relationships in CORE.

3.2.1 Alternatives

The allocation of functions to components resulted in the physical architecture shown in Figure 3-3.

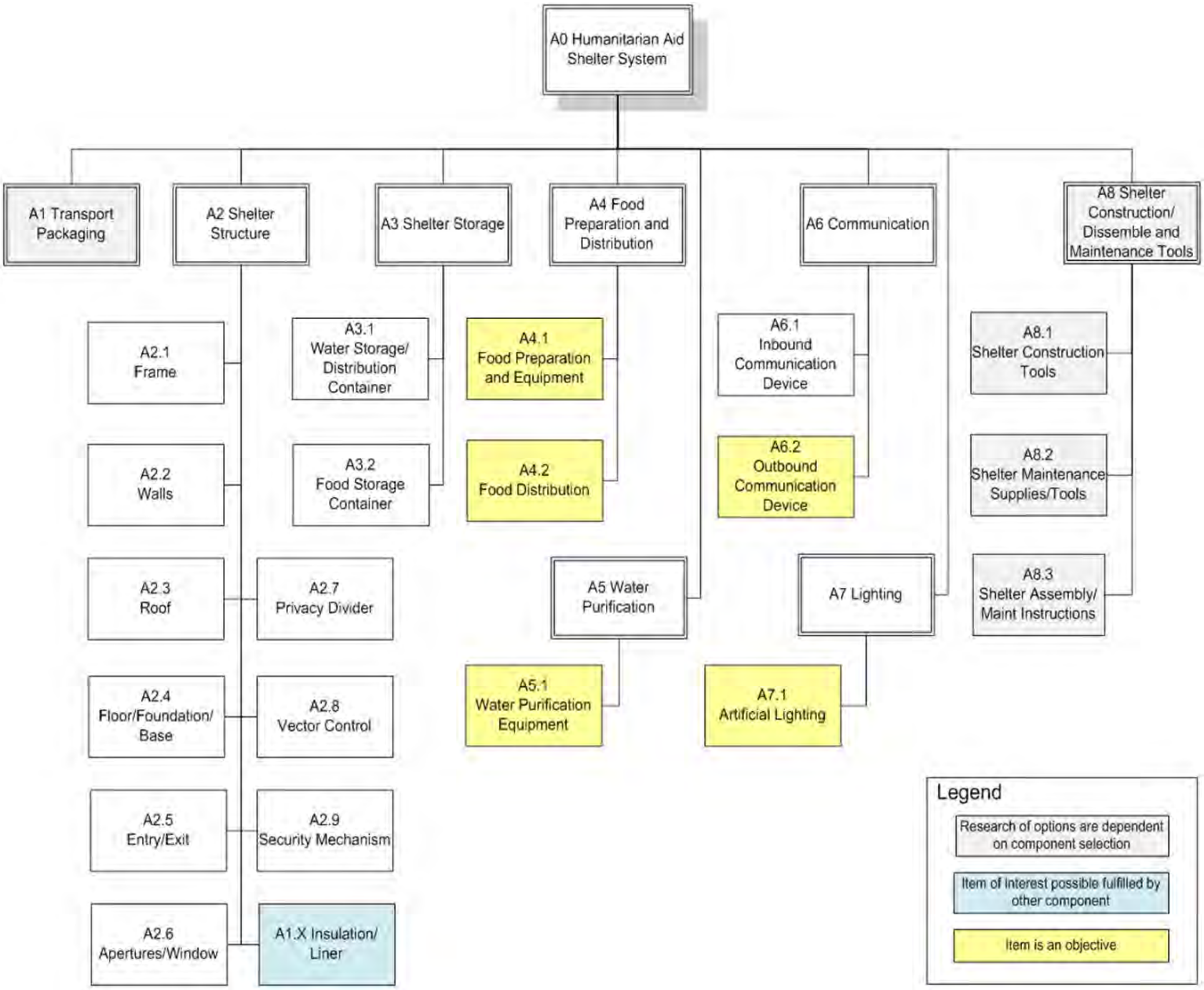


Figure 3-3 HASS Physical Architecture

Each component was assigned to a team for identification of alternative solutions. The teams conducted further research into the identified alternatives to assess their capability,

suitability, how well they fulfilled the requirements, cost, and availability. More detail into the research performed by each team is provided in the following paragraphs.

In many instances, trade-off studies examined different system elements which could have performed the system's functions. In some cases, the trade-offs were between entirely different physical alternatives for the system as a whole. This section describes process and results.

3.2.1.1 Shelter Structure Alternatives

A number of shelters were analyzed for suitability in fulfilling the requirements specified in the Mission Needs Statement and System Specifications documents. A checklist listing the requirements was generated and used during review of each alternative. The checklist included space to delineate how the requirements were fulfilled, any comments for clarification, and the degree to which the requirements were fulfilled, i.e., Yes, No, Partially, and Unknown. Each shelter analyzed will be discussed in the following paragraphs. Following the overview of each shelter, the summary of the checklist review is presented in Table 3-2.

3.2.1.1.1 Base X Shelters

The Base X Shelters are a family of shelters used by the US Marine Corps. They range in size from a 4-person tent up to a version that is over 935 sq ft and can be used as a command post. The two of particular interest were the HDT_303 in Figure 3-4 and HDT_505 in Figure 3-5. These shelters meet or exceed all military requirements for environmental conditions, water resistance, transportability, safety, and ventilation. Additionally, Base X shelters include a wiring harness compliant with US and foreign specifications. Unfortunately, one shortcoming of these shelters was that the doors on these shelters are not securable.

Figure 3-4 Base X HDT_303 Shelter

Source of picture is (HDT Base-X® Model 303 2011).

Figure 3-5 Base X HDT_505 Shelter

Source of picture is (HDT Base-X® Model 505 2011).

3.2.1.1.2 Cal-Earth Shelter

The Cal-Earth Shelter (Figure 3-6) was the only shelter assessed that was designed to be ecologically friendly. Made basically of earth packed in tubular bags, it does not require much material. It does require at least one trained person to direct the construction. With adequate waterproofing, most environmental conditions will not present a problem. There are no tripping hazards with this shelter. The only items to be shipped are the bags, so this system is very transportable and scalable. This HASS is 100% COTS and local material. Windows provide natural lighting and ventilation; how you construct the windows determine whether they can be closed or not. How the door is constructed determines whether it can be secured or not.

Figure 3-6 Cal-Earth Eco Dome

Source of picture is (Emergency Shelter Village 2011).

3.2.1.1.3 EvenShelter

Similar to the other manufacturers developing the shelters discussed in this section, EvenProducts Limited is a participant in the Shelter Centre, a Non-Governmental Organization (NGO) supporting that portion of the humanitarian community interested in housing relief in post-conflict and natural disasters. *Transitional Shelter Standards* (Shelter Centre 2010) served as a frequent reference during the course of this project. A related Shelter Centre document, *Transitional Shelter Prototypes* (Shelter Centre 2009), served as a useful source of shelter alternatives to evaluate. One of these prototypes was an EvenProducts Limited shelter, the EvenShelter (see Figure 3-7). The EvenShelter was designed for warm, hot, dry, or wet climates. The tarpaulin used has been wear-tested and warranted for five years. The interior frame is made of bamboo; it has been treated for borers and does not rot under damp conditions. The covered area of 16 sq m is sufficient for 5 persons. Natural ventilation is provided through the ridge at the apex of the shelter. These can be partially or totally closed. Multiple shelters can be joined to provide greater space. Adequate clearance is provided for ingress/egress. There are no interior poles to present a hazard to personal or exterior guidelines. As seen in the Base X alternatives, the door for the EvenShelter not securable.

Figure 3-7 EvenShelter

Source of picture is (Even Shelters 2011).

3.2.1.1.4 Hexayurt

The Hexayurt Project hosts designs for cost effective shelters that can be built using local materials. The project advertises its designs as a “free hardware shelter technology” and provides a public domain design solution, but no hardware. The project maintains all designs, but makes them freely available to any person looking to implement them. The Hexayurt design can be built in plywood and has up to 166 square feet (15 sq m) of living space. Figure 3-8 illustrates one of the Hexayurt Project’s many designs.

Figure 3-8 Hexayurt

Source of picture is (Hexayurtcity 2011).

3.2.1.1.5 Flexayurt

The Flexayurt by HOMErgent (Figure 3-9) is an implementation of the Hexayurt design described above. Unlike the Hexayurt, the Flexayurt design is not open to the public; rather it is the commercially available version of the Hexayurt. It was designed to provide comfortable living conditions and maximum resource self-sufficiency at relatively low costs. The Flexayurt design offers similar portability and scalability as tents with more versatility. The design provides 160 square feet of living space, and can be built in less than 60 minutes.

Figure 3-9 Flexayurt

Source for picture is (Flexayurt 2011).

3.2.1.1.6 Maddel International

Similar to several other the transitional shelter manufacturers discussed in this section, Maddel International was included in the Shelter Centre publication “Transitional Shelter Prototypes” (Shelter Centre 2009) due to their involvement in the development of the Transitional Shelter Standards document. Maddel International offers three shelter designs; two were considered for selection, the Mk2 and Mk5 (Figure 3-10). Unlike the Maddel Mk2, the Mk5 can be modified for long-term use. Additionally, the Mk5 is based on a common polypropylene unit module that can be joined together in clusters of 4 to 6 units. Each unit provides 77.5 square feet of living space in each module and a common area in the middle. The Mk5 is a new design by Maddel resembling a traditional shelter that can be extended by connecting multiple units together. It is constructed of polypropylene and has 193.8 square feet of living space. . Regrettably, the Mk5 was not yet available for purchase at the time of review while the Mk2 was manufactured in Australia which presented a scheduling challenge (Maddel International 2011).

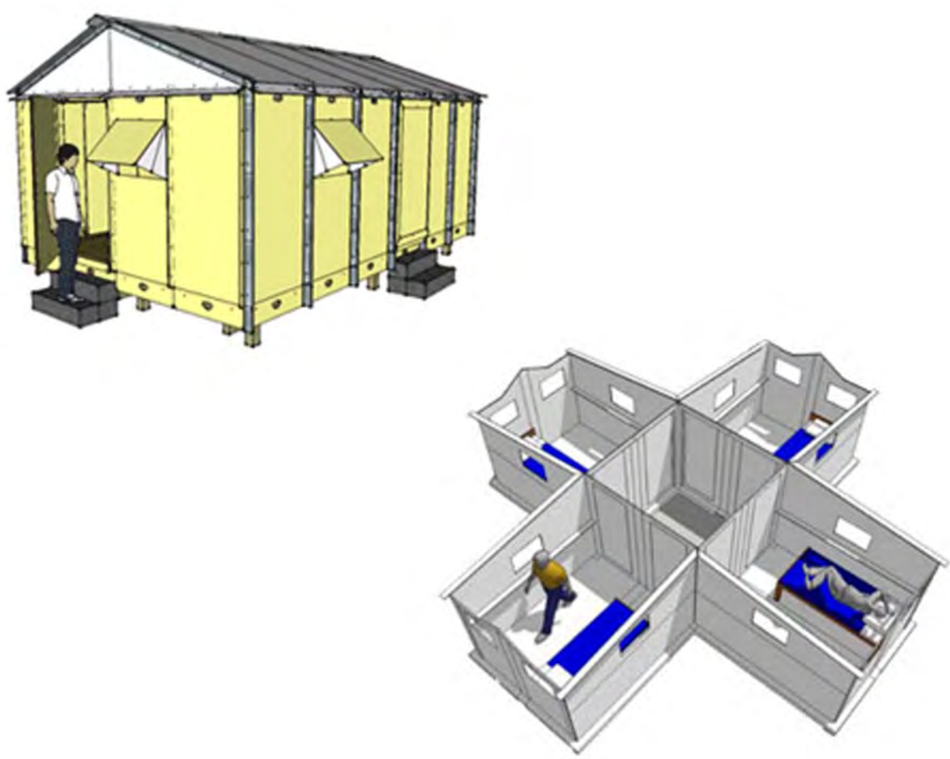


Figure 3-10 Maddel Mk2 (left) and Mk5 (right)

Source of pictures are (Shelter MK 5 2011) and (Shelter MK 2 2011).

3.2.1.1.7 Series 1100

The Series 1100 Transitional Shelter is available from Worldwide Shelters through a partnership with VersaTube Building Systems. The design of the Series 1100 was also guided by the Shelter Centre's Transitional Shelter Standards (Shelter Centre 2010). Worldwide Shelters' goal was to fully integrate the Shelter Centre's standards into a lightweight-transitional shelter while providing sustainable, cost-effective housing. During the review of this shelter, it was determined evidence of this goal could be seen in the final product. The most attractive feature of this shelter is its high adaptability. To extend the shelter's life cycle beyond that of the polyester, cotton fabric cover, the Series 1100 was designed to be a true transitional shelter where local materials could be used to convert, or transition, the shelter from temporary to permanent housing. In additional to the Series 1100 in its emergency/transitional form, an example of the Series 1100 frame being used in conjunction with local materials to form a more permanent housing structure can be seen below in Figure 3-11. This particular shelter was constructed in Haiti (Worldwide Shelters 2011).

Figure 3-11 Series 1100

Source of pictures are (Worldwide Shelters 2011) and (Series 1100 Emergency/Transitional Shelter 2011).

3.2.1.1.8 TransHome Shelter

The TransHome shelter (Figure 3-12) designed by NRS International (NRS International 2011) was also developed in accordance with the Shelter Centre's *Transitional Shelter Standards* (Shelter Centre 2010) and was included in their supplemental *Transitional Shelter Prototypes* (Shelter Centre 2009) publication. Therefore, not surprisingly, the TransHome meets a number of the team's basic requirements. It has 17.64 sq m covered floor space. Ingress/egress is easily accommodated. The walls are 2.0 m high. No individual component weighs more than 40 lbs. The door comes with a lock. However, the exterior guide ropes and interior fabric flooring do present tripping hazards. Unfortunately this shelter is manufactured in and shipped from China. Also it is only sold by full container; each container can hold either twenty or forty shelters.

Figure 3-12 TransHome Shelter

Source of picture is (NRS International 2011).

3.2.1.1.9 TranShel

World Shelters' TranShel (Figure 3-13) (TranShel 2011) is a frameless hard-panel structure, or "shell", designed for transitional housing. World Shelters development of the TranShel was in accordance with *Transitional Shelter Standards* (Shelter Centre 2010) generated by the Shelter Centre; this meant that the TranShel met a number of our requirements including use of local materials for adaptability. Unfortunately, the cost of the shelter put this option at a disadvantage during alternative selection.

Figure 3-13 TransShel

Source of pictures are (TranShel 2011) and (TranShel 2011).

3.2.1.1.10 TS200

Nunatak Systems' TS200 Transitional Shelter (Figure 3-14) (Transitional Shelter TS200 2011) is a temporary house based on a re-useable and durable aluminum frame at a relatively low price point (Nunatak Systems 2010). Nunatak describes the shelter as twice the cost of a traditional family tent. The TS200 was also developed with the guidance of the *Transitional Shelter Standards* (Shelter Centre 2010) published by the Shelter Centre. Additionally, like the TranShel, it was also listed in the Shelter Centre's publication, *Transitional Shelter Prototypes* (Shelter Centre 2009), Draft (November, 2009). As suggested by its inclusion in this publication, the TS200 met many of our requirements, but due to country of origin (Germany) and schedule challenges it was not available for selection.

Figure 3-14 TS200

Source of picture is (Transitional Shelter TS200 2011).

3.2.1.1.11 Uber Shelter

The Uber Shelter (Figure 3-15) (Uber Shelter 2011) was the only multi-level option researched. This shelter was assessed by Engineering Review International for structural capacity for dead, live, wind and earthquake loading as they pertain to Port au Prince, Haiti. This assessment indicated the structure met our Threshold requirements for wind; with additional bracing the Objective requirements could be met (Griffin 2010). This shelter has a total of 192 sq ft (17.8 sq m) covered floor space. The door is sealable. The shelter is raised off the ground and can be leveled. This shelter is very transportable; transport size is 4 x 8 x 2.5 ft and one standard pallet can hold eight shelters. A mini-stove and refrigerator can also be procured with this shelter. As an upgrade to the basic unit, two solar panels can be added to provide power for interior and exterior lights and to power a small refrigerator. There is a minimum of one window on each exterior wall to allow natural lighting and ventilation. This shelter is very scalable. Scalability options include adding a single room or multiple units can be configured into a duplex or even a fourplex.

Figure 3-15 Uber Shelter

Source of picture is (Uber Shelter Blog 2011).

3.2.1.1.12 Summary of selection

Upon completing the checklist review process the individual alternatives were compared. A summary of this comparison can be seen below (Table 3-2). In addition to each alternative's feasibility, as a measure how well they fulfilled each system specification, the availability and cost of the alternative were considered in the selection process. Some of the alternatives were discovered to not be commercially available, eliminating them from further consideration. While some were still prototypes, others had another challenge, as they were manufactured in China or Germany. Due to perceived complications of a Department of Defense acquisition from China and potential schedule constraints accompanying possible extended shipping times, these options were not pursued. Additionally, some options were precluded from selection due to cost, e.g. TranShel. Ultimately, the Series 1100 Transitional Shelter was selected due to the results of the checklist review, availability, price and manufacturing proximity.

Although the final selection meets many of our project requirements and system specifications, it should be noted, given lesser schedule constraints, further investigation of additional feasible alternatives would have been pursued to ensure a truly exhaustive search.

Table 3-2 Shelter Comparison

	Base X	CalEarth	Even Shelter	Flexayurt	Mk2	Mk5	Series 1100	TranShel	TransHome	TS200	Uber Shelter
Operating Conditions	Yes	Partially	Yes	Partially	Partially	Partially	Yes	Yes	Yes	Yes	Partially
Lifecycle	?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?
Shelter Occupancy	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shelter Modification	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
COTS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-Flammable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-Toxic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Color	Partially	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Partially	Yes
Transportability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Natural Lighting	Yes	Partially	Yes	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Occupant Privacy	?	No	Yes	No	Yes	Yes	Yes	No	No	Yes	Partially
Ventilation	Yes	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scalability &	Yes	Yes	Partially	No	Yes	Yes	Partially	No	Yes	Yes	Yes
Operability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ingress/Egress	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partially
Majory Assembly	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	?
Safety	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vector-Born Disease	?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security	No	Partially	No	Yes	Yes	Yes	Partially	Partially	Yes	Partially	Yes
Availability	**Yes**	**Yes**	**No**	**Yes**	****Partially**	**No**	**Yes**	**Yes**	***Partially**	***Partially**	**No**
Unit Cost	n/a	n/a	n/a	n/a	n/a	n/a	$ 1,350	$ 3,000	n/a	n/a	n/a

*Manufactured/shipped from China
**Manufactured/shipped from Australia

3.2.1.2 Water Storage and Distribution

The *water storage and distribution equipment* requirements for the HASS stemmed from the need to be able to store, handle and distribute water for the shelter occupants in a safe and efficient manner; therefore, many of the associated MOPs relate to water quality, distribution, weight, and overall size. Standard MOPs such as cost and expected life cycle were also considered. Unique MOPs such as the container size when not filled and container operating temperatures were also considered, as these metrics affect water quality and the pack-out space required.

Commercially available water storage and distribution equipment with the potential to meet our requirements varied across a wide range of price and technological sophistication. The analysis of alternatives (AoA) was constructed using three different water storage and distribution platforms. The comparison results of these equipment items and attributes (including the number of requirements actually met) are shown in Table 3-3 below. Pictures of the various items are shown in Table 3-4 below. Illustrations of equipment variants having a capacity of one gallon were not shown.

After careful consideration and review of the AoA results, it was determined that the Harris Manufacturing High Stress Collapsible Water Bag (HSCWB) was the preferred alternative. Although the HSCWB was the most expensive, it was also the most capable and reliable of the alternatives. The HSCWB also incorporates capabilities which the stakeholders were not aware of (but might appreciate), such as the ability to be air-dropped full of water. The HSCWB also has extremely high abrasion resistance, and can be worn as a backpack for easy transport to/from water supply points. The cost was also relatively low when compared to other components in the system, and therefore did not have as dramatic of an effect on the selection decision as other MOP criteria.

Table 3-3 Water Storage and Distribution Equipment Attributes

		Water Storage and Distribution											
Preference	Number	Vendor Name	URL	Model Name	Description	Water Resistant	Weight	Dimensions	Operating Temps	Cost	Reliability	Expected Lifecycle	Requirements Met
1	1	Harris MFD/DOD CFD		HSCWB-5 Gal	High Stress Collapsible Water Bag. 5 Gallon Capacity. Air dropable From 40 Ft. Abrasion resistant. Shoulder straps for carrying. Grommets for hanging. Includes valve for distribution. Can hang to take shower.	Yes	2.2 Lbs	18L x 8W x 4D	-10,125	100	High	5 Years	6 of 6
	2	Harris MFD/DOD CFD		HSCWB-1 Gal	High Stress Collapsible Water Bag. 1 Gallon Capacity. Air dropable From 40 Ft. Abrasion resistant. Includes valve for distribution.	Yes	.68 Lbs	14L x 9.5W x .5D	-10,125	15	High	5 Years	6 of 6
3	3	Scepter	URL	5877	MWC 5 Mil Water Can	Yes	6 Lbs	18.5H x 14L x 6.7W	-25,125	42	High	5 Years	4 of 6
2	4	Reliance	http://www.relianceproducts.com/products/hydration/87.html	Fold-A-Carrier II Blue 5G/20L	The Fold A Carrier II is guaranteed not to crack, leak, punture, or break under normal use. Excellent 5 gallon portable water carrier for emergencies, picnics, outings, off-road adventures. Our five gallon collapsible water carrier is available in Blue, Red or Clear. These collapsible five gallon water containers are a great choice for facility managers, emergency personnel and disaster relief coordinators to have on hand prior to a disaster. FEMA and the Redcross has used these containers with great success. Having these lightweight food grade plastic drinking water containers available to distribute drinking and bathing water will help people help themselves in time of need! Because they can collape to 2" high many can be stored in a smaller space and easily delivered to the area of need.	Yes	.77 Lbs	11"Lx3.5"x16"	32,140	10	Low	5 Year Warranty	6 of 6
	5	Reliance	http://www.relianceproducts.com/products/hydration/80.html	Fold-A-Jug 1G/4L	Fold-A-Jug 1G/4L Folds neatly to save space FDA, food approved polyethylene- no odor or taste Flexible even in extreme cold Large neck opening lets you add ice cubes Size: 1 gallon / 4 liters	Yes	.29 lbs	5.75"Lx3"Wx7.5"H	23,140	7.49	Low	5 Year Warranty	5 of 6

Table 3-4 Water Storage and Distribution Equipment Pictures

Water Storage and Distribution Equipment Item	**Picture**
Harris Manufacturing Five Gallon High Stress Collapsible Water Bag (HSCWB)	

Water Storage and Distribution Equipment Item	Picture
Scepter Standard Five Gallon Military Issue Water Can (Scepter 2007)	
Reliance Five Gallon Fold-A-Jug (Reliance 2006)	

3.2.1.3 Food Preparation

The *food preparation equipment* requirements for the HASS stemmed from the need to: a) have a food preparation capability for 5-10 people, and b) provide the most efficient, flexible and capable selection of food preparation equipment possible. Therefore, many of the MOPs associated with these requirements relate to capability, performance and cooking methods. These three performance factors are important to food preparation equipment in an austere and limited environment because they govern the types of food you can prepare and how efficiently and effectively you can prepare that food. Other standard MOPs such as weight, size, water resistance, purchase cost and life cycle cost were also considered.

There were many MOPs to consider when choosing food preparation equipment applicable to an HA/DR scenario. During the market investigation process, it was evident that one key MOP (purposely left out of the requirements so as not to limit the scope of research) was to be the most critical: (cooking) fuel flexibility. Food preparation equipment that can only

utilize a single type of fuel (wood, coal or gas) tends to minimize its own operational availability. Our top performer was equipment capable of operating with solid or gas fuel, besides meeting all of the other requirements.

The separate food preparation equipment researched and their respective attributes, including the number of requirements met, can be seen in Table 3-5 below. Pictures of the food preparation equipment can also be seen in Table 3-6 below.

Table 3-5 Food Preparation Equipment Attributes

		Food Preparation Equipment											
Preference	#	Vendor Name	URL	Model Name	Description	Water Resistant	Weight	Dimensions	Operating Temps	Cost	Flexibility	Expected Lifecycle	Requirements Met
5	1	ICRC	URL	Stove, Firewood, Heating and Cooking	STOVE/HEATER, wood/coal burner, REDI CAL C2, + cook.pot	No	77	.1m^3	NA	7-40	Solid Fuel	High	2 of 6
3	2	Camp Chef	URL	Alpine	Free standing cylinder stove	Yes	74	22.5" H x 20" W x 20" D	NA	220	Solid Fuel	High	4 of 6
4	3	Cadac	URL	Safari Chef Camping Stove	Versitile free standing cooking device	No	16	20" H x 15" W x 17" D	Na	100	Gas Fuel	High	6 of 6
1	4	Volcano	URL	Volcano II with Gas and cover	Versitile Multi-Fuel Stove that collapses	No	19	17" Diameter x 5" Height	NA	165	Solid & Gas	High	6 of 6
2	5	Volcano	URL	Volcano II (No Gas capability) and no cover	Versitle Stove that collapses (Wood & Charcoal Fuel Only)	No	16	15.5" Diameter x 5" Height	NA	87	Solid & Gas	High	6 of 6

Table 3-6 Food Preparation Equipment Pictures

Food Preparation Equipment Item	Picture
Volcano II Collapsible Multi-Fuel Stove (Volcano Grills n.d.)	
Camp Chef- Alpine (Cymax 2005-2011)	

Food Preparation Equipment Item	Picture
Cadac-Safari Chef Camping Stove (CSN Stores 2002-2011)	
ICRC Stove, Firewood, Heating and Cooking (International Federation of Red Cross and Red Crescent Societies (ICRC) 2011)	

After careful consideration and review of the AoA results, the Volcano II collapsible stove was preferred over the other alternatives. While the Volcano II had a relatively high cost, it appeared to be the most capable and flexible of the alternatives. This was due to its multi-fuel capability, which allowed the stove to run off charcoal, wood, propane or any other combustible solid fuel. This flexibility drastically increased its operational availability.

The Volcano II was completely modular and collapsed down to a 5” thick disk which minimizes pack-out volume. The weight of the Volcano II was equal to or less than the other alternatives, which provided for simpler transport and reduced logistics costs associated with shipping and handling. The Volcano II also provided the widest range of cooking capabilities of any alternative. It can boil, braise, pan fry, griddle and bake. The cost of the Volcano II was also relatively low compared to other components within the HASS, and cost therefore did not have as dramatic of an effect on the selection decision as other MOP criteria.

3.2.1.4 Food Distribution

The *food distribution equipment* requirements for the HASS stemmed from a need to be able to distribute a variety of foodstuffs to the shelter user, including food that was hot, cold,

cooked, solid, or liquid. MOPs associated with these requirements related to contents, construction material, weight and overall size.

In researching preassembled kits that fulfilled the requirements, three options were found that met International Committee of the Red Cross (ICRC) / International Federation of the Red Crescent (IFRC) (International Federation of Red Cross and Red Crescent Societies 2011) standards. Hasanco (Hasanco Group 2011) and Techno Relief (Techno Relief Group 2011) are internationally-based suppliers of these kits; obtaining cost information proved challenging. In addition to our inability to obtain price quotes from these companies, sourcing HASS components from an international supplier was ultimately deemed infeasible for the purposes of the project, based on the established timeline and funding sources. The IFRC also had a kit available on their website which could have met the requirements, but no response was provided when asked whether one could be procured for the purpose of the HASS.

Due to the unavailability of the first three options, a custom kit (based on a combination of commercially available sets) was selected to fulfill the requirements. The capabilities of the four different food distribution systems are shown in Table 3-7 below. Pictures of the alternatives are included in Table 3-8 below.

Table 3-7 Food Distribution Equipment Attributes

		Food Distribution Equipment								
Preference	Number	Vendor Name	URL	Model Name	Description	Water Resistant	Weight	Dimensions	Operating Temps	Cost
4	1	Hasanco	URL	Kitchen Set A	**ICRC / IFRC Type Kitchen Sets Stainless Steel for 5**	Yes	12.32	11" x 11" x 9.5"	NA	
3	2	Techno Relief Group	URL	Kitchen Set A	**ICRC / IFRC Type Kitchen Sets Stainless Steel for 5**	Yes	11	11.81 "x 11.81" x 9.85"	NA	
2	3	ICRC	URL	Kitchen Set A	**ICRC / IFRC Type Kitchen Sets Stainless Steel for 5**	Yes	11	.0243m^3	NA	$31.66
1	4	Survivalequipment.com-Walmart.com-webstaurantstore.com	URL	1)Surv:#COOK148321 2)Surv:#COOK343301 3)Webstaur:407SP13 4)Walmart: 5063642 5)Walmart:0001601705799	1) Sierra Table Set-16pc ($36.45)-2) Ring Cutlery Set ($6.95)-3) Stainless Steel Bucket($15.99)-4) 5" Mini Chef Knife ($10.00)-5) Mainstays 10-Piece Cookware Set ($39.00): This kit is for 4 people, ordering 2 kits would cost ($248.70) as some items need not be ordered.	Yes	22	2.8ft^3	NA	$129.35

This table provides the 4 alternatives considered for Food Distribution Equipment including their measures of performance/attributes. The preference column indicates that the custom kit in the 4th row was most preferred.

Table 3-8 Food Distribution Equipment Attributes

Food Distribution Equipment Item	**Picture**
Customized Food Distribution Kit **1.** Sierra Table Set - 16 pc **2.** Farberware 5" Mini Chef Knife **3.** Mainstays 10-Piece Cookware Set, Stainless Steel **4.** 13 Quart Stainless Steel Utility Pail **5.** Ring Cutlery Set	 1. (Survival Equipment 2011) 2. (Wal-mart 2011) 3. (Wal-mart 2011) 4. (Webstaurant Store 2011) 5. (Survival Equipment 2011)
ICRC/IRFC Kitchen set Type A	 (International Federation of Red Cross and Red Crescent Societies 2011)
Techno Relief Group version ICRC/IRFC Kitchen set Type A	 (Techno Relief Group 2011)

Food Distribution Equipment Item	Picture
Hasanco version ICRC/IRFC Kitchen set Type A	 (Hasanco Group 2011)

This table provides pictures of alternatives analyzed for food distribution equipment

The customized kit was selected as the preferred alternative for the HASS based on primarily on availability and project constraints. Based on the price provided on the International Federation of Red Crescent's website, which was less than 25% the cost of the customized kit, the food distribution equipment component offers an area for possible cost reductions for the HASS.

3.2.1.5 Food Storage

The *food storage equipment* requirements for the HASS stemmed from a need to be able to provide the HASS' occupants the ability to store food in manner that protects it from the environment and prolongs the shelf-life. The food for storage may include but is not limited to excess cooked food and provided food from other sources. The associated requirements include the ability to protect the storage contents from the environment, container quantity per household, and container volume. The volume and quantity requirements were derived from recommendations made by a Navy-Master Chief (Navy Master Chief Culinary Specialist (Jamieson 2011) with 25 years of Navy cooking experience. The container quantity per household is derived from the need to store the four major food types provided with a meal: starches, proteins, vegetables, and an alternate. The alternate could consist of fruit or a dessert.

Measures of Performance related to food storage equipment include: volume, weight, water tight, air tight, cost, operating temperature, and expected lifecycle. There is no shortage of options available on the commercial market to satisfy the food storage requirements for the HASS. Table 3-9 below illustrates the four alternatives that were selected and considered during the AoA. During the comparison, price became the primary discriminator for selection as each

alternative offered comparable performance characteristics. The semi-clear 6-quart round polypropylene container with a clear polyethylene lid (manufactured by Cambro) was selected as the preferred food storage equipment alternative for the HASS. Pictures of the various products are included in Table 3-10 below.

This table provides the 4 alternatives considered for Food Storage Equipment including their measures of performance/attributes. The preference column indicates that the Cambro round 6 quart storage container in the 1st row was most preferred

Table 3-9 Food Storage Equipment Attributes

		Food Storage Equipment												
Preference	**Number**	**Vendor Name**	**MFG**	**URL**	**Model Name**	**Description**	**Water Resistant**	**Weight**	**Dimensions**	**Operating Temps**	**Cost**	**Qty Required**	**Reliability**	**Reqs Met**
1	1	katom.com	Cambro	http://www.katom.com/144-RFS6PP190.html	Model 144-RFS6PP190	**Storage Container**, Round, 6 qt., 9-15/16" dia. x 7-15/16"H, translucent, polypropylene, NSF. Cover sold separately	Yes	.71 lbs	9-15/16" dia. x 7-15/16"H	-40F,160F	$2.90	4.0	High	3 of 3
	2	katom.com	Cambro	http://www.katom.com/144-RFSC6PP190.html	Model 144-RFSC6PP190	**Cover** for Storage Container, 6 & 8 qt., clear, polyethylene	Yes	.19 lbs		-40F,160F	$1.02	4.0	High	3 of 3
2	3	Rubbermaidforless	Rubbermaid	http://www.rubbermaidforless.com/rubbermaid-5723-round-storage-container-capacity-white-product_info-926.html	Product Model: 5723	Rubbermaid 5723 Round **Storage Container** - - 6 qt. capacity - White (Material - PP)	Yes	.73 lbs	10" Dia. x 7.63" H	-20F, 212F	$3.96	4.0	High	3 of 3
	4	Rubbermaidforless	Rubbermaid	http://www.rubbermaidforless.com/rubbermaid-5725-5723-572324-5724-572424-round-storage-containers-1025-product_info-933.html	Product Mode: 5725	**Lid** for 5723 (LLDPE)	Yes	.3 lbs	10.25"Dia x 1"	-20F, 212F	$2.31	4.0	High	3 of 3
3	5	Rubbermaid	Rubbermaid	URL	#7J76	6 QT Square Container & Lid (Polycarbonate)	Yes		16.5" x 11.5" x 3.5"	-40F,160F	8.54	4.0	Medium	3 of 3
4	6	Cambro	Cambro	URL	6SFSCW, LID:SFC6SCPP	6 QT Square Container & Lid (Polycarbonate)	Yes	1.25	8 3/8" x 8 3/8" x 7 1/4"	-40F,210F	9.64	4.0	High	3 of 3

Table 3-10 Food Storage Equipment Pictures

Food Storage Equipment Item	Picture
Cambro 6 qt. Round Storage (Polypropylene)with lid	 (Cambro Manufacturing Company 2011)
Rubbermaid 6 qt. Round Storage Containers (Polypropylene) and Lids	 (Rubbermaid For Less 2011)
Rubbermaid Square 6 qt. Storage Containers with Lids (Polycarbonate)	 (Rubbermaid 2011)
Cambro Square 6 qt. Storage Containers with Lids (Polycarbonate)	 (Cambro Manufacturing Company 2011)

3.2.1.6 Water Purification

The water purification equipment requirements for the HASS stemmed from a need to purify potentially contaminated indigenous freshwater sources. Indigenous freshwater sources are defined as any natural freshwater source such as wells, rivers, lakes, and streams. Many of the MOPs associated with these requirements are related to water quality and the necessary

quantity of purified water to be provided per person (or per shelter) per day. Standard MOPs (cost, expected life cycle, etc.) derived from NSF P248 (P248 Emergency Military Operations Microbiological Water Purifiers January 2006) and TB-MED 577 (TB MED 577 Sanitary Control and Surveillance of Field Water Supplies 2005) were considered along with unique MOPs such as operating temperatures, as these metrics can affect the ability of the purification solution to operate successfully in all intended environments.

When looking at commercially available water purification equipment and evaluating them against the specified requirements, the solutions ranged across all spectra: cheap to expensive, old to new technologies, from communal to individual solutions. The ultimate AoA featured eleven (11) different water purification equipment items.

For simplification, two different purification perspectives were examined while analyzing possible solutions. The first perspective included provision for a water purification solution for each individual HASS. In other words, each shelter would have the capability to purify water – no matter if there were 2 or 200 HASS deployed.

The second perspective utilization of water purification solution is for communal usage. This would mean that whether 1 HASS system was deployed, or 20 HASS systems were deployed, there would be a communal solution deployed that was dependent on the total number of HASS systems deployed. These 11 separate equipment items and their respective attributes, including the number of requirements met, can be seen in Table 3-11 and Table 3-12 for the individual solutions below and Table 3-13 and Table 3-14 for the communal solutions below. Pictures of the water purification equipment items can also be seen in Table 3-15.

Table 3-11 Individual Water Purification Equipment Attributes Summary

	Vendor Name	Model Name	Water Resistant	Weight	Dimensions	Operating Temps	Cost of component	Cost of filters	# of extra filters needed in 2.5 years if used everyday for 50L of water	Total cost of ownership over 2.5 year lifecycle	Expected Lifecycle
1	Katadyne	Pocket	Yes	550g	24 x 6 cm		284.99	130	0	284.99	20 years
2	Monolithic	Just Water	Yes	700g	12" x 29"		60	40	5	260	N/A
3	First Need	XL	Yes	454g	6.25 x 4.9 x 2.8	33° - 100°F	112	55	80	4512	
4	Katadyne	BaseCamp	Yes	620g	7.5 x 4 inches		70	40	3	190	2 year
					WATER PURIFICATION METHODS						
6	Potable Aqua	Chlorine Dioxide tablets	Yes	26g		60 to 86F	14	14	913	12782	1 year
7	Steripen	Adventurer Opti	Yes	295g	6.1 x 1.5 x 1 inch	32F to 140F	150	150	5	900	5 months
8	Steripen	Sidewinder	Yes	471g	8.6 in. x 5.5 in. x	32F to 140F	100	100	5	600	5 months

Table 3-12 Individual Water Purification Requirements met in AoA

			Requirement Verification				
	Requirement #		3.5.7	3.5.7.1	3.5.7.2	3.5.7.2	3.5.7.3
	Threshold/Objective		Objective	Objective	Threshold	Objective	Objective
	Title		Water Purification, Storage, and Distribution	Water Purification Temperature.	Water Purification Rate	Water Storage Weight	Water Purification Quality
	Water Purification Equipment						
Rank	Vendor Name	Model Name					
3	Katadyne	Pocket	Yes	Yes	Yes	Yes	No, only Eliminates bacteria, protozoa, cysts, algae, spores, sediments and viruses in combination with particles greater than 0.2 microns. Will need a water purification mechanism.
1	Monolithic	Just Water	Yes	Yes	Yes	Yes	No, only Eliminates bacteria, protozoa, cysts, algae, spores, sediments and viruses in combination with particles greater than 0.2 microns. Will need a water purification mechanism.
4	First Need	XL	Yes	Yes	Yes	Yes	Yes
2	Katadyne	BaseCamp	Yes	Yes	Yes	Yes	No, only Eliminates bacteria, protozoa, cysts, algae, spores, sediments and viruses in combination with particles greater than 0.2 microns. Will need a water purification mechanism.
			WATER PURIFICATION METHODS				
3	Potable Aqua	Chlorine Dioxide tablets	Yes	Yes	Yes	Yes	No, purifies the water from virus and containments, requires a water filter above to remove containments.
1	Steripen	Adventurer Opti	Yes	Yes	Yes	Yes	No, purifies the water from virus and containments, requires a water filter above to remove containments.
2	Steripen	Sidewinder	Yes	Yes	Yes	Yes	No, purifies the water from virus and containments, requires a water filter above to remove containments.

Table 3-13 Communal Water Purification Equipment Attributes Summary

	Water Purification Equipment										
	Vendor Name	Model Name	Water Resistant	Weight	Dimensions	Operating Temps	Cost of Component	Cost of Filters	# of filters needed in 2.5 years if used everyday for 50L of water	# of HASS's per day that could be supported with 1 system	Expected Lifecycle
1	Aqua Sun International	Outpost S	Yes	300lbs	49" long x 26" wide x 34" tall		8500	400	2	74	>2.5 years
2	Katadyn	Survivor 35	Yes	7.05 lbs	4.7 X 22 X 3.5	36-113	1,800	340	30	2	Not Listed
3	General Ecology INC	First Need Base Camp	Yes		4.125D X 8.875H	33,100	692				Not Listed
4	Katadyn	Expedition	Yes	11.5 lbs	8D X 23H		1035	150	54	115	Not Listed

Table 3-14 Communal Water Purification Requirements met in AoA

	Requirement #		Requirement Verification				
			3.5.7	3.5.7.1	3.5.7.2	3.5.7.2	3.5.7.3
	Threshold/Objective		Objective	Objective	Threshold	Objective	Objective
	Title		Water Purification, Storage, and Distribution	Water Purification Temperature.	Water Purification Rate	Water Storage Weight	Water Purification Quality
	Water Purification Equipment						
	Vendor Name	Model Name					
3	Aqua Sun International	Outpost S	Yes	Yes	Yes	Yes	Yes
1	Katadyn	Survivor 35	No	No	Yes	Yes	No
4	General Ecology INC	First Need Base Camp Portable	Yes	No	Yes	Yes	Yes
2	Katadyn	Expedition	Yes	Yes	Yes	Yes	No

Table 3-15 Water Purification Equipment Items

Water Purification Equipment Item	**Picture**
Katadyn Pocket	 (Katadyn Group 2011)
Monolithic Just Water	 (Monolithic 2011)
First Need XL	 (REI 2011)
Katadyn Base Camp	 (Katadyn Group 2011)

Water Purification Equipment Item	Picture
Portable Aqua Chlorine Dioxide Tablets	 (Potable Aqua 2011)
SteriPEN Adventure Opti	 (SteriPEN 2011)
SteriPEN Sidewinder	 (SteriPEN 2011)

Water Purification Equipment Item	Picture
Aqua Sun International Outpost S	 (Aqua Sun 2011)
Katadyn Survivor 35	 (Katadyn 2011)
First Need Base Camp	 (General Ecology 2011)
Katadyn Expedition	 (Katadyn 2011)

After carefully considering the results of the AoA, the best solution appeared to be an individual (shelter) water purification system as discussed herein. After analysis, the cost savings of communal solution was outweighed by the need to ultimately maintain and operate the communal solution. The communal solution did not lend itself to the concept of a self-

sustaining shelter system. The ultimate solution chosen was a combination of different equipment: the SteriPEN Sidewinder and the Monolithic Just Water.

The combined solution was selected in order to meet the water quality standards in the Technical Bulletin for Sanitary Control and Surveillance of Field Water Supplies (TB-MED-577) (TB MED 577 Sanitary Control and Surveillance of Field Water Supplies 2005) dated Dec 2005. The standards defined in TB-MED-577 include both filtration and purification of water. Filtration of water is defined as the removal of bacteria, algae, spores, and containments from the water. Purification of water is defined as the removal of viruses and containments from the water. Of the possible individual solutions, only one could accomplish both filtration and purification; however, that solution had an extraordinarily high price tag. The winning system combined separate filtration and purification systems. The filtration solution was the Monolithic Just Water system, which uses a ceramic filter to remove particles and other containments from the water. The purification solution was the SteriPEN Sidewinder, which utilizes ultraviolet light to purify the water. The combination does not require batteries or external power, instead utilizing a hand-operated crank for operation providing one liter of water in 90 seconds. The SteriPEN Sidewinder and Monolithic Just Water require replacement of the UV light and ceramic filter, respectively, for every five months the system is in operation.

3.2.1.7 Communications

A communication need was identified by stakeholders early in the requirements development process for the HASS. Once shelter, food, and water were secured, the ability to communicate was felt to be an integral part of life, especially in disaster situations. The initial communication requirement was an ability to receive one-way (to the displaced person) broadcasts. As the project progressed, the one-way capability was established as the threshold for acceptability; two-way communication was established as the objective. Further discussion and research helped to solidify the communication capability with specific range and frequency requirements. Ultimately the decision was made to keep the requirement at the most basic level. This would allow the various communication options to remain open in consideration of the variety of geographical locations in which the shelter system was expected to serve.

During the AoA, it became evident that many communications platforms met the basic requirements. Continuing research revealed several options which met both threshold and

objective requirements. Our final list of potential solutions included twelve options. These options were separated into two categories: One-way communication sources (or shortwave radio), and two-way communication sources. Given that the initial cost of both one-and two-way options were relatively similar, additional considerations were needed for separation. When logistics and life cycle cost were factored in, a radio which could provide its own power would be essential. Table 3-16 below shows the one-way communication options. Table 3-17 shows the two-way communication options.

Given the wide range of possibilities, the Midland XT511 was selected. It is a two-way radio with a 26 mile communication range. A major decision factor for the Midland XT511 was the ability for the unit to be powered by a variety of sources: rechargeable/replaceable batteries, AC or DC adapters, or the organic hand crank. The radio will provide 30 minutes of talk time in two-way communication mode with 90 seconds worth of hand crank. Given its adequate range, self-power ability, low initial cost, and the fact that it meets the objective requirement, the Midland XT511 was selected as the preferred communication system for the HASS.

Table 3-16 One Way Communications Options

SHORTWAVE RADIOS

	Sangean		Sony	Kaito		Grundig		Eton
	 1	 2	 3	 4	 5	 6	 7	 8
Feature	ATS-404	ATS-505	ICF-SW7600GR	KA-1101	KA-1102	G8	G6	FR360
Frequency Range	520 - 1710kHz 2.3 - 26.1 MHz	520 - 1710kHz 1711-29999 kHz 87.5-108 MHz	150 to 29999 kHz 87.6 - 108 MHz	520-1710 kHz 3000 to 26100 kHz 70.0 - 95.5 MHz	522-1710 kHz 3000-29990 kHz	3190-3450, 3850-4050, 4700-5100, 5700-6300, 7080-7600, 9200-10000, 11450-12200, 13500-13900, 15000-15900, 17450-17900, 18850-19100 and 21430-21950 kHz	150-29999 kHz 87.5-108 MHz 117-137 MHz	520-1710 KHz 87-108MHz
Scanning	YES	YES	YES	YES	YES	YES	YES	
Memories	45	45	100	50	190	500	700	7
FM Stereo	YES	YES	YES	YES	YES	YES	YES	YES
Keypad	YES	YES	YES	YES	YES	NO	YES	NO
Tune Knob	NO	YES	NO	NO	NO	NO	YES	YES
AC Pwr Supply	YES	YES	OPT.	YES	YES	OPT	YES	YES
Battery	4 AA	4 AA	4 AA	3 Ni-MH	3 Ni-MH	3 AA	2 AA or NiCad	NO
Emergency Pwr								Crank and Solar PWR
Recorder	NO	NO	NO	NO	NO	NO	NO	NO
Ext Ant Jack	NO	YES	YES	YES	YES	NO	NO	NO
Cost	$ 68.00	$ 107.03	$ 130.88	$ 59.99	$ 69.99	$ 49.95	$ 89.99	$ 37.76
Retailer	Amazon	Amazon	B&H Photo & Video	Amazon	Amazon	Barnes & Noble	Amazon	Ace Hardware

	http://www.universal-radio.com/catalog/portable/chartp.html
1	http://www.amazon.com/Sangean-ATS-404-Digital-Shortwave-Receiver/dp/B0000226L0
2	http://www.amazon.com/Sangean-ATS-505P-Stereo-Synthesized-Receiver/dp/B000066R6K
3	http://www.bhphotovideo.com/c/product/642936-REG/Sony_ICFSW7600GR_ICF_SW7600GR_FM_Stereo_World.html
4	http://www.amazon.com/Kaito-KA1101-Portable-radio/dp/B000669GA8
5	http://www.amazon.com/Kaito-KA1102-Portable-radio/dp/B00065X51U
6	http://gifts.barnesandnoble.com/Eton-Traveler-II-Digital-G8-Radio-Tuner/e/750254803895?r=1&cm_mmc=Google%20Product%20Search-_-Q000000630-_-Eton%20Traveler%20II%20Digital%20G8%20Radio%20Tuner-_-750254803895
7	http://www.amazon.com/Grundig-G6-Aviator-aircraft-Shortwave/dp/B0014T5UM4
8	http://www.etoncorp.com/product_card/?p_ProductDbId=915826 http://www.acehardwaresuperstore.com/dynamo-crank-powered/7609.html

Source information for pictures and data are: (Universal Radio 2011) (Amazon 2011) (Amazon 2011) (bhphotovideo 2011) (Amazon 2011) (Amazon 2011) (Barnes & Noble 2011) (Amazon 2011) (Eton Corporation 2011) (Ace Hardware Superstore 2011).

Table 3-17 Two Way Communications Options

	Midland XT511	Midland GXT1000VP4	Motorola MR350R	Cobra Electronics MicroTalk CXR800
Channels	22 FRS/GMRS and 7 Weather	50 FRS and GMRS	7 FRS / 15 GMRS	22 (GMRS)
Privacy Codes	121	387	121	
Vox	Yes	Yes	Yes	Yes
Channel Scan	Yes	Yes	No	Yes
Range	26 miles	36 miles	35 miles	27 miles
AC or DC	Both	(charging)	No	(charging)
Batteries	4 AA	4 AA	3 AA or NIMH	Li-Ion
Other pwr	Emer Crank	No	No	No
Talk Time	12 hours battery / 30 min per 90 sec crank		9 Hours on NIMH, 27 Hours AA	
Frequencies	GMRS 462.550 ~ 467.7125 MHz			
	AM 530 ~ 1700 kHz			
	FM 87.9 ~108.1 MHz			
Size	6 x 7 x 2.25	7.25 x 2.5 x 1.4	7 x 2.25 x 1 inches	
Weight	3 lbs	4.8 ounces	3.6 ounces	.2 lbs
Cost	$ 56.50	$ 63.48	$ 50.99	$ 89.95
Retailer	Amazon	Amazon	Amazon	Cobra
Notes	Emer Wx Alert	Emer Wx Alert	Emer Wx Alert	
	Requires FCC liscence to operate on GMRS	Requires FCC liscence to operate on GMRS	Requires FCC liscence to operate on GMRS	

9 10 11 12

9	http://www.amazon.com/Midland-XT511-22-Channel-Two-Way-Emergency/dp/B000P0O12I
	http://www.midlandradio.com/Two-Way-Radio.BS3/XT511-Base-Camp
10	http://www.amazon.com/Midland-GXT1000VP4-36-Mile-50-Channel-Two-Way/dp/B001WMFYH4
	http://www.midlandradio.com/New-Arrivals2.K16/GXT1000VP4
11	http://www.amazon.com/Motorola-MR350R-35-Mile-22-Channel-Two-Way/dp/B001UE6MJ8
	http://www.motorola.com/Business/US-EN/Business+Product+and+Services/Two-Way+Radios+-+Consumers/MR350R-VP_Talkabout_Two-Way-Radio_US-EN
	http://www.rei.com/product/793588/motorola-mr350r-2-way-radios-pair
12	https://www.cobra.com/detail/microtalk-cxr800-27-mile-radio-with-weather.cfm

Sources for the pictures and data are: (Amazon 2011) (Midland Radio 2011) (Amazon 2011) (Midland Radio 2011) (Amazon 2011) (Motorola 2011) (REI 2011) (Cobra 2011).

3.2.1.8 Lighting

3.2.1.8.1 Natural Lighting

The natural lighting requirements for the HASS were identified by the cohort early to provide lighting to the HASS' occupants for activities utilizing available sunlight, as a threshold. As an objective, the lighting equipment was to contain the capability to adjust the incoming natural lighting, as well as the capability to secure the opening of the HASS. The HASS has the following features for openings to provide natural lighting (Series 1100 Emergency/Transitional Shelter 2011):

- ✓ 2 Doors with #10 zippers
- ✓ 2 windows per door (one per panel) 19 ½"W x 38 ½"H

  These windows have fiberglass screen and full-cover flaps, which may be closed on 3 sides with Velcro or may be rolled up and secured with tie tapes.
- ✓ 2 windows (87 ½"W x 13"H) placed at opposite ends of tent walls for maximum cross-ventilation. Window flaps close on 3 sides with 1" Velcro and may be rolled up and tied in place with tie tapes. Fiberglas screen.
- ✓ Stovepipe shield has 5" round opening. Entire shield covers an area 16"W x 17"H and has a flap which ties back when a stove is used or closes with Velcro if there is no stove.

Figure **3-16** shows the natural lighting in the shelter.

Figure 3-16 HASS Interior View

Source of the pictures is (Series 1100 Emergency/Transitional Shelter 2011).

3.2.1.8.2 Artificial Lighting

The artificial lighting requirements for the HASS were identified by the cohort early to provide lighting to the HASS' occupants for activities after dark in a in a safe and efficient method. Therefore, many of the MOPs associated with these requirements are related to light distribution, and power required. Standard MOPs such as cost (initial purchase and battery replacement) and expected life cycle were also considered.

A number of shelter lighting options were considered with the selection ranging from military emergency hospital type lighting to camping lighting. The power requirements for the options run from battery to electricity to solar powered, and their cost varies widely. The chosen design at the cohort's IPR #2, the Oxley model, was the result of selecting from the different lighting options. However, at the lighting design team evaluation discovery, another selection for lighting, the d.light S250, was selected and purchased. The reason was due to the fact that the d.light S250 is solar powered, which would eliminate the logistical need for a power supply. This is an important factor, eliminating the need for electricity generation and/or providing batteries for thousands of shelters, therefore making solar-powered lighting self reliant, increases the operational availability, by reducing the frequency of replacing batteries and downtime. Another deciding factor was the cost, Table 3-18 below shows that the d.light S250 is the most economical to meet the needs at initial purchase (not including to the power supply needed by the rest of the lighting considered). Consideration was given to the d.light selection battery replacement, based on the fact that there will be 5 units of the light allotted for each shelter. Thus not all the lights will be used all at once, the d.light battery is scheduled to be replaced 18-24 months, based on normal operation (Tozun n.d.), there should be adequate lights for usage, with multiple lights available, therefore the rechargeable batteries should last as long as the shelter. These four separate lighting items and their respective attributes, including the tabulated requirements, are shown in Table 3-19. Pictures of the lightings are in Table 3-20.

Table 3-18 Lighting and Lighting/Power Attributes

	Lighting			
	d.light	Oxley	McGeoch LED	MOCO Enterprises, LLC
Specification	Description	Description	Description	Description
Electrical	S250 Solar	120V AC / 18 watts DC	10/230 VAC, 50/60Hz	60-220Vac 24-48 Vdc
	• White light illumination ~ 3-5 Watt CFL lamp • 3-5 Watt CFL is ~ 23 Watt incandescent	15 hours of burntime	20 Watt - white primary lights lit at full power	
	Battery pack NiMH Life 18-24 months		40 Watt Maximum - all LED's,	
			Battery pack NiMH Life 3 years	
Light output	High: Studying/Precision work	1,500 lumens of cool white light	White: 1200lm (dims to 0lm)	Green: Dimmable 5%
	Medium: Working/Cooking		CRI:<85	
	Low: Walking/Socializing		Blue: 30lm	
	Night light: Resting/Sleeping		Red: 30lm	
			Emergency: 60lm	
Environmental	• Weather resistant solar panel	Operating temperature: -50 degrees Fahrenheit to +120 degrees Fahrenheit (-46 degree Celsius to +49 degrees Celsius	Operating Temperature: -40 to +71C (Heat sink must be in free air)	Operating temperature: -55 to +55C
		-50 degrees Fahrenheit to +160 degrees Fahrenheit (-46 degrees Celsius to +71 degrees Celsius)	Storage temperature: -40 to +71C	
			Sealing: IP68	IP67 (MIL810)
			Shock/vibration: Land class B	
			EMC: Def Stan 59/41 Land class B	EMI Shielding: Not required
MTBF	50,000 hrs (excluding battery replacement)	50,000 hours	50000 hours	20000 hours
Materials	High efficiency polycrystalline solar panel		Heat sink/substrate: Extruded aluminum	
Weight	0.350 Kg (Lantern only)	22 oz. (0.62 Kg)		1.03kg (2.26 lbs)
Dimension	0.350 Kg 13.7 x 12.7 x 13 cm (Lantern only)		92mm X 100mm X 750mm	
Cost	$45/ea for 1 test unit; $45/ea for 1000 units		£750/ea for 1 test unit; £450-£500/ea for 1000 units	$ 400/ea for 1 test unit; $350/ea for 1000 units
Reference	http://www.dlightdesign.com	http://www.oxleygroup.com/getdoc/05a132fa-1e67-4cd5-8f0f-aa187792b810/SHEL.aspx	http://www.mcgeochLED.com	http://www.moco.com

Table 3-19 Lighting Selection and Requirement

			Requirement #	3.4.9	3.4.10	3.4.10.1
			Title	Natural Lighting	Artificial Lighting	Artificial Lighting Performance
			Threshold/Objective	Threshold/Objective	Objective	Objective
			Description	The HASS shall be capable of providing natural light to the internal volume (Threshold). The HASS shall have provisions to adjust the amount of natural light entering the HASS from 0% to 100%. Provisions for providing natural light shall be securable and closable (Objective). When secured and closed, provisions for natural lighting shall be opaque.	The HASS shall have provisions for artificial lighting (Objective).	Artificial lighting provisions shall be capable of providing 500 LUX to all covered floor space in the HASS in accordance with MIL-STD-1472D: Table XV (Objective).
	Lighting					
	Vendor	Model	Vendor Specification			
1	d.light	S250	http://www.dlightdesign.com	NA/NA	YES	NO
2	Oxley	Portable LED	http://www.oxleygroup.com/getdoc/05a132fa-1e67-4cd5-8f0f-aa187792b810/SHEL.aspx	NA/NA	YES	NO
3	McGeoch	LED	http://www.mcgeochLED.com	NA/NA	YES	NO
4	MOCO	Portable LED	http://www.mocolightingproducts.com/index.html	NA/NA	YES	NO

Table 3-20 Lighting Choices and Lighting Pictures

Lighting	**Picture**
d.light S250	 (Dlight Design Company 2011)

Lighting	Picture
Oxley	 (Oxley Group 2011)
McGeoch	 (McGeoch LED 2011)
MOCO	 (MOCO Company 2011)

3.2.2 Trade-offs

When all research into the individual components was completed, the teams were asked to identify up to four preferred options. The criteria used to determine the preferred options, such as cost or capability, were left to the individual teams. The entire group then met to develop variants for final consideration. Originally four function points were identified from simply meeting threshold requirements to the most capable option. These four variants resulted in acquisition costs ranging from $1466 to $3,835. Further analysis revealed that including water purification and artificial lighting which are both Objective requirements in the most capable

variant increased the cost significantly. Therefore two more variants were defined for Most Capable without Water Purification and Most Capable without Water Purification and Artificial Lighting resulting in costs of $2,975 and $2,176 respectively. Table 3-21 shows the costs for the different variants. More detail per component is provided in the following paragraphs.

Table 3-21 Total Costs for All Variants

	Total Cost
Threshold Only	1453.28
	1819.63
	4179.63
Most Capable	3801.53
Most Capable/No Water Purification	2941.53
Most Capable/No Water Purification/No Artificial Lighting	2141.53

The Shelter Team identified the T1100 w/Tarp as the most basic alternative as shown in Table 3-22. The T1100 can be built with other siding material, either locally acquired or purchased along with the basic frame. The T1100 w/All Steel was identified as the most capable. Another alternative similar to the T1100 is the TS200.

Table 3-22 Shelter Ranking

	Shelter	
	Component	Cost
Threshold Only	Series 1100 With Tarp	1350
	Series 1100 w/ Local Materials	1500
	TranShel	3000
Most Capable	Series 1100 w/ Local Materials	1500
Most Capable/No Water Purification	Series 1100 w/ Local Materials	1500
Most Capable/No Water Purification/No Artificial Lighting	Series 1100 w/ Local Materials	1500

At the Threshold level, the Water Purification Team had no requirement, as shown in Table 3-23. Once a system met the basic requirements, there was no appreciable difference in performance. The system chosen performs the best of the available alternatives for the price.

Table 3-23 Water Purification Ranking

	Water Purification	
	Component	Cost
Threshold Only	Filtration and Purification	
	Water/Steripen	
	Water/Steripen	860
Most Capable	Water/Steripen	860
Most Capable/No Water Purification	Water/Steripen	
Most Capable/No Water Purification/No Artificial Lighting	Water/Steripen	

The Water Storage and Distribution Team identified two alternatives as shown in Table 3-24. Once the basic need had been fulfilled, there was not much difference between alternatives providing greater capability. The alternative chosen provided the best value for the cost.

Table 3-24 Water Storage and Distribution Ranking

	Water Storage & Distribution	
	Component	Cost
Threshold Only	Fold-A-Jug/Fold-A-Carrier	50
	Fold-A-Jug/Fold-A-Carrier	50
	Fold-A-Jug/Fold-A-Carrier	50
Most Capable	Harris HSCWB 5Gal & 1 Gal	275
Most Capable/No Water Purification	Harris HSCWB 5Gal & 1 Gal	275
Most Capable/No Water Purification/No Artificial Lighting	Harris HSCWB 5Gal & 1 Gal	275

There was no requirement for food preparation at the Threshold level. Once more capability was required, the variations available in the selected system made it stand out among all the alternatives. One low cost variation was listed to provide an additional cost data point, but the cost for the most capable variation made it the variation of choice. Table 3-25 shows the costs of the various alternatives.

Table 3-25 Food Preparation Ranking

	Food Preparation	
	Component	Cost
Threshold Only		
	Volcano II No Gas-No Cover	87
	Volcano II No Gas-No Cover	87
Most Capable	Volcano II With Propane	165
Most Capable/No Water Purification	Volcano II With Propane	165
Most Capable/No Water Purification/No Artificial Lighting	Volcano II With Propane	165

For food distribution and food storage there was no significant difference among the alternatives researched so only one alternative was proposed as shown in Table 3-26 and Table 3-27.

Table 3-26 Food Distribution Ranking

	Food Distribution	
	Component	Cost
Threshold Only		
	Custom SPEC Kit	129.35
	Custom SPEC Kit	129.35
Most Capable	Custom SPEC Kit	129.35
Most Capable/No Water Purification	Custom SPEC Kit	129.35
Most Capable/No Water Purification/No Artificial Lighting	Custom SPEC Kit	129.35

Table 3-27 Food Storage Ranking

	Food Storage	
	Component	Cost
Threshold Only	Preference-A-Cambro	15.68
	Preference-A-Cambro	15.68
	Preference-A-Cambro	15.68
Most Capable	Preference-A-Cambro	15.68
Most Capable/No Water Purification	Preference-A-Cambro	15.68
Most Capable/No Water Purification/No Artificial Lighting	Preference-A-Cambro	15.68

The Communications Team identified three different alternatives as shown in Table 3-28. Two of the alternatives had such minor cost difference and performance difference as to be interchangeable.

Table 3-28 Communications Ranking

	Communication	
	Component	Cost
Threshold Only	Eton Fr360	37.60
	Eton FR 360	37.60
	Eton FR 360	37.60
Most Capable	Midland XT511	56.50
Most Capable/No Water Purification	Midland XT511	56.50
Most Capable/No Water Purification/No Artificial Lighting	Midland XT512	56.50

There is no requirement for artificial lighting at the Threshold level as shown in Table 3-29. Once a requirement exists, three different alternatives were identified.

Table 3-29 Lighting Ranking

	Lighting	
	Component	Cost
Threshold Only		
	MOCO	350
	MOCO	350
Most Capable	McGeoch LED	800
Most Capable/No Water Purification	McGeoch LED	800
Most Capable/No Water Purification/No Artificial Lighting	McGeoch LED	

3.3 Design Results

The final design of the HASS system had to correspond to the HASS physical architecture and requirements as defined in the Mission Needs Statement and System specification. The HASS physical architecture is depicted in Figure 3-3 above.

An AoA was performed on all physical components independent from each other. Final recommendations were made regarding solutions for each of the physical components per the analysis performed. The HASS was then assessed from the perspective of a complete system and different variations of the system were analyzed. The variants reviewed are described in Table 3-30 below and they align to the HASS physical architecture A2-A7 components. Components A1 and A8 of the physical architecture were not assessed as part of the analysis of the HASS due to the project's focus on a shelter itself vice the support mechanisms of transportation and shelter construction/disassembly/maintenance tools. Those components of the physical architecture were important but were not the focus of the team's effort.

Table 3-30 Variant Summary

	Shelter	Water Purification	Water Storage & Distribution	Food Preparation	Food Distribution	Food Storage	Communicatio	Lighting	Total Cost	
	Component	Component	Component	Component	Component	Component	Component	Component		
Threshold Only	Series 1100 With Tarp		Fold-A-Jug/Fold-A-Carrier			Preference-A-Cambro	Eton Fr360		1453.28	V1
	Series 1100 w/ Local Materials		Fold-A-Jug/Fold-A-Carrier	Volcano II No Gas-No Cover	Custom SPEC Kit	Preference-A-Cambro	Eton FR 360	MOCO	1819.63	V2
	TranShel	Water/Steripen	Fold-A-Jug/Fold-A-Carrier	Volcano II No Gas-No Cover	Custom SPEC Kit	Preference-A-Cambro	Eton FR 360	MOCO	4179.63	V3
Most Capable	Series 1100 w/ Local Materials	Water/Steripen	Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT511	McGeoch LED	3801.53	V4
Most Capable/No Water Purification	Series 1100 w/ Local Materials		Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT511	McGeoch LED	2941.53	V5
Most Capable/No Water Purification/No Artificial Lighting	Series 1100 w/ Local Materials		Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT512		2141.53	V6

As depicted in the above table a number of capability vs price point systems can be put together ranging from $1,453.28 without objective requirements of water purification, food preperation, food distribution, and lighting to the high end of $4,179.63 to meet all objective and threshold requirements for the HASS system.

3.4 Quality Functional Deployment

The Quality Function Deployment (QFD) (Fabrycky 2006) method provided a framework from which the development team could visually trace requirements as they were decomposed from the stakeholder needs (the voice of the customer) to engineering characteristics of the final system. Application of this process helped to ensure visibility of requirements throughout system development. It could also serve as a check-and-balance

mechanism which permits stakeholders to see how their needs were traced through to the final design. Only the first three Houses of Quality (HOQ) were used, mapping customer requirements with physical characteristics and manufacturing requirements of the system.

3.4.1 QFD 1

The Analytical Hierarchy Process (AHP) (Kwinn 2009) was employed to gain insight into the stakeholders' needs by sorting and prioritizing the top level requirements. Once the AHP was complete, with weights to each of the top level requirements, the first House of Quality (HOQ 1) could be populated. The Top level requirements were entered into the QFD chart (see Figure 3-17) along with the weighted values for each requirement. Additionally the Key Performance Parameters (KPPs) were entered to complete the table. Relative values for how well the KPPs addressed the top level requirements were entered into the table in order to gain an associated score for each KPP.

Customer Requirement (Whats)	Weights		Space Per Occupant (Minimum 5 People)	Rain Column applied without leaks	Packaged on a Pallet	Operational Life Cycle	Reliable	All tools for HASS are COTS	Slope of Terrain 12 inches over 20 ft	Cost
			sq meters	mm	Inches	Years	Units	Units	Units	dollars
The shelter solution shall be capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes.	0.085981	0.086	3	9			6		3	
The HASS system shall survive an operational usage for a minimum of 2.5 years.	0.07822	0.078	3			9				
The shelter solution shall be able to be transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.	0.174686	0.175			9	3				
The HASS shall provide shelter for 5 - 10 occupants.	0.235423	0.235	9							
HASS shall be able to be constructed by untrained personnel with the supplied tools.	0.061391	0.061					3	9		
The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95% (threshold) and 99% (objective) of shelters with a lower bound 90% confidence interval.	0.08647	0.086	6	6		9	9			
The HASS shall be capable of operations in various terrain environments.	0.149558	0.150					6		9	
The HASS shall be Affordable	0.128271	0.128	3	3	3	6	6	9	3	
Check Sum	1	1.00								
Goal Value			4.5	2500	45x48	5	0.99	N/A	N/A	500
Threshold Value			3.5	1500	88x108	2.5	0.95	N/A	N/A	2300
Weighted Performance			3.5	1.7	2.0	2.8	3.1	1.7	2.0	0.0
Percent Performance			0.210	0.100	0.117	0.166	0.188	0.102	0.119	0.000

Figure 3-17 HOQ1: Requirements vs. KPP

3.4.2 QFD 2

After completion of HOQ 1, it is possible to begin populating the next level of the QFD matrix. HOQ 2 is used to show the relationship between the key performance parameters and the functions the system is required to perform. The KPP information is brought forward from HOQ 1 along with weighted values associated to each KPP. The system function information is provided by the SV-4 (Figure 3-18). Once again, a relative value is associated to how well each system function accomplishes the required KPPs. As with the HOQ 1, these relative values are used to assess weighed scores for each system function.

KPPs	Weights		Deploy	Survive Storage	Transport	Assemble	Provide Scalable operation	Operate	Protect	Use Shelter	Serve	Dispose	Remove Components	Disassemble Structure	Discard Structure
			Units	Units	Units	Units	Units	Units	Units	Units	Units	Units	Units	Units	Units
Space Per Occupant (Minimum 5 People)	3.51504	0.210					9		9	9	3				
Rain Column applied without leaks	1.677458	0.100							9						
Packaged on a Pallet	1.956989	0.117		6	9										
Operational Life Cycle	2.775893	0.166		6											
Reliable	3.14526	0.188								9					
All tools for HASS are COTS	1.706956	0.102			3	9							9	9	9
Slope of Terrain 12 inches over 20 ft	1.988782	0.119							9						
Cost	0	0.000													
Check Sum	16.76638	1.00													
Goal Value															
Threshold Value															
Weighted Performance			0.0	1.7	1.4	0.9	1.9	0.0	3.9	3.6	0.6	0.0	0.9	0.9	0.9
Percent Performance			0.000	0.102	0.081	0.055	0.113	0.000	0.231	0.215	0.038	0.000	0.055	0.055	0.055

Figure 3-18 HOQ2: Function vs. Performance

3.4.3 QFD 3

HOQ 3 is the final level of the QFD matrix which was used to trace the system requirements. In HOQ 3 (see Figure 3-19), the system functions and their weights are compared to actual component forms to show how important each form is in addressing the stakeholder

needs. The forms are assigned a relative value for how well they fulfill the required functions of the system.

Functions	*Weights*		*Forms*: Transport Packaging	Shelter Structure	Water Storage	Food Storage	Food Preparation and Distribution	Water Purification	Communication	Lighting	Shelter Construction, Diassembly and Maintenance Tools
Survive Storage	1.693705	0.102	9	6				3		3	
Transport	1.355914	0.081	9	9							
Assemble	0.916274	0.055		9							9
Provide Scalable operation	1.886833	0.113		9			3				
Protect	3.854829	0.231		9							
Use Shelter	3.575173	0.215		6			6			3	
Serve	0.628944	0.038			9	9	9	9	6	3	
Remove Components	0.916274	0.055								3	9
Disassemble Structure	0.916274	0.055		9							9
Discard Structure	0.916274	0.055		9							9
Check Sum	16.6605	1.00									
Goal Value											
Threshold Value											
Weighted Performance			1.6	7.2	0.3	0.3	2.0	0.6	0.2	1.2	2.0
Percent Performance			0.106	0.463	0.022	0.022	0.126	0.041	0.015	0.079	0.127

Figure 3-19 HOQ3: Function vs. Form

QFD 3 shows that the structural component of the system is the most important form for fulfilling stakeholder needs. The other highly weighted forms which were determined by the QFD process were the tools, food preparation equipment, and transport packaging. This information provided the design team with a metric to use in when choosing between different

possible design solutions for each form. Additionally, the values determined by the QFD process were used in completion of the Cost as an Independent Variable (CAIV) analysis.

3.5 Cost as an Independent Variable (CAIV) Analysis

CAIV is an important tool in the decision making process that helps the design team make a decision when multiple concept variants can meet the customer requirements. The CAIV analysis tool draws on data provided by the Quality Functional Decomposition. Information in the CAIV is also derived from the MNS, MOEs and MOPs. The principles of CAIV were derived from lessons learned through the MSSE program at NPS. Initial demonstration of this principle was provided by Professor Mark Rhodes as part of SE3303, System Assessment. (Rhodes 2010)

The CAIV analysis began by creating an attribute table (see Table 3-31) from the list of forms found in QFD 3. These forms are given a metrics associated to Low, Medium, and High scores. The metrics assigned to each of these values can be traced back to the MNS. Additionally, a scoring table (see Table 3-32) was created to assign numerical values to each Low, Medium, and High score.

Table 3-31 Attribute Table

Attribute Table	Units	L	M	H
Transport Packaging		3 Pallets	2 Pallets	1 Pallet
Shelter Structure		Soft (Tent)	Hardened	Local Materials
Water Storage		Low Grade Plastic	High Grade Plastic	Silicon / Nylon
Food Storage		Low Grade Plastic		High Grade Plastic
Food Preparation and Distribution		Meets Req	Meets Req + 2 Fuel Types	Meets Req + 3 Fuel Types
Water Purification		Ext Pwr Req		No Ext Pwr Req
Communication		One Way, Ext Pwr	One Way, Organic Pwr	Twp Way, Organic Pwr
Lighting		Natural Light	500 Lux	Variable output
Shelter Construction, Diassembly and Maintenance Tools		Specialized Tooling Req'd		Common Tools Required

Table 3-32 Attribute Scoring Table

Attribute Scoring Table		L	M	H
Transport Packaging		0.25	0.5	1.0
Shelter Structure		0.25	0.5	1.0
Food and Water Storage		0.25	0.5	1.0
Food Preparation and Distribution		0.25	0.5	1.0
Water Purification		0.25	0.5	1.0
Communication		0.25	0.5	1.0
Lighting		0.25	0.5	1.0
Shelter Construction, Diassembly and Maintenance Tools		0.25	0.5	1.0

Once these two tables were created, the design team then began to populate a variant scoring table, Table 3-33, which gave each variant a score for each attribute area, Table 3-34.

Table 3-33 Design Variants

	Shelter	Water Purification	Water Storage & Distribution	Food Preparation	Food Distribution	Food Storage	Communication	Lighting	Total Cost	
	Component	Component	Component	Component	Component	Component	Component	Component		
Threshold Only	Series 1100 With Tarp		Fold-A-Jug/Fold-A-Carrier			Preference-A-Cambro	Eton Fr360		1453.28	V1
	Series 1100 w/ Local Materials		Fold-A-Jug/Fold-A-Carrier	Volcano II No Gas-No Cover	Custom SPEC Kit	Preference-A-Cambro	Eton FR 360	MOCO	1819.63	V2
	TranShel	Water/Steripen	Fold-A-Jug/Fold-A-Carrier	Volcano II No Gas-No Cover	Custom SPEC Kit	Preference-A-Cambro	Eton FR 360	MOCO	4179.63	V3
Most Capable	Series 1100 w/ Local Materials	Water/Steripen	Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT511	McGeoch LED	3801.53	V4
Most Capable/No Water Purification	Series 1100 w/ Local Materials		Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT511	McGeoch LED	2941.53	V5
Most Capable/No Water Purification/No Artificial Lighting	Series 1100 w/ Local Materials		Harris HSCWB 5Gal & 1 Gal	Volcan II With Propane	Custom SPEC Kit	Preference-A-Cambro	Midland XT512		2141.53	V6

Table 3-34 Variant's Scores

	V1	V2	V3	V4	V5	V6
Measured/ Calculated Values	Score	Score	Score	Score	Score	Score
Transport Packaging	0.25	0.25	0.50	0.25	0.25	0.25
Shelter Structure	0.25	1.00	0.25	1.00	1.00	1.00
Water Storage	0.25	0.25	1.00	1.00	1.00	1.00
Food Storage	1.00	1.00	1.00	1.00	1.00	1.00
Food Preparation and Distribution	0.00	0.50	1.00	1.00	1.00	1.00
Water Purification	0.00	0.00	1.00	1.00	0.00	0.00
Communication	0.50	0.50	1.00	1.00	1.00	1.00
Lighting	0.00	0.50	0.50	1.00	1.00	0.00
Shelter Construction, Diassembly and Maintenance Tools						
mean	0.65	0.73	0.78	0.78	0.72	0.66

With the scores associated to variants for each attribute area a mean score was then calculated for each proposed design solution. These raw mean scores were then fed into another table which accounted for the weighted value of each variant as determined in the QFD process. These weighted values trace directly back to the input provided by stakeholders when they completed their AHP inputs. When the raw scores were multiplied by the weighted attribute values, the design team was able to determine the Overall Measure of Effectiveness (OMOE) for each variant (see Table 3-35).

Table 3-35 OMOE Table

	Transport Packaging	Shelter Structure	Water Storage	Food Storage	Food Preparation and Distribution	Water Purification	Communication	Lighting	Shelter Construction, Diassembly and Maintenance Tools	OMOE
	0.106	0.463	0.022	0.022	0.126	0.041	0.015	0.079	0.127	1.000
V1	0.25	0.25	0.25	1.00	0.00	0.00	0.50	0.00		0.177
V2	0.25	1.00	0.25	1.00	0.50	0.00	0.50	0.50		0.626
V3	0.50	0.25	1.00	1.00	1.00	1.00	1.00	0.50		0.434
V4	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.794
V5	0.25	1.00	1.00	1.00	1.00	0.00	1.00	1.00		0.752
V6	0.25	1.00	1.00	1.00	1.00	0.00	1.00	0.00		0.674

With the OMOE values determined for each variant, the next step in the CAIV process was to plot the OMOE values against the variant cost (see Figure 3-20). Given the immaturity of the system, the design team decided to limit cost consideration to initial system cost. Additionally, the operational concept calls for deploying the system and leaving it in place. It is to require little to no maintenance. With these factors in mind, the design team decided that support cost would be minimal for the system and initial cost should be sufficient for completing the CAIV analysis.

Name	OMOE	Cost
V1	0.177	$1,453.28
V2	0.626	$1,819.63
V3	0.754	$4,179.63
V4	0.794	$3,801.53
V5	0.752	$2,941.53
V6	0.674	$2,141.53

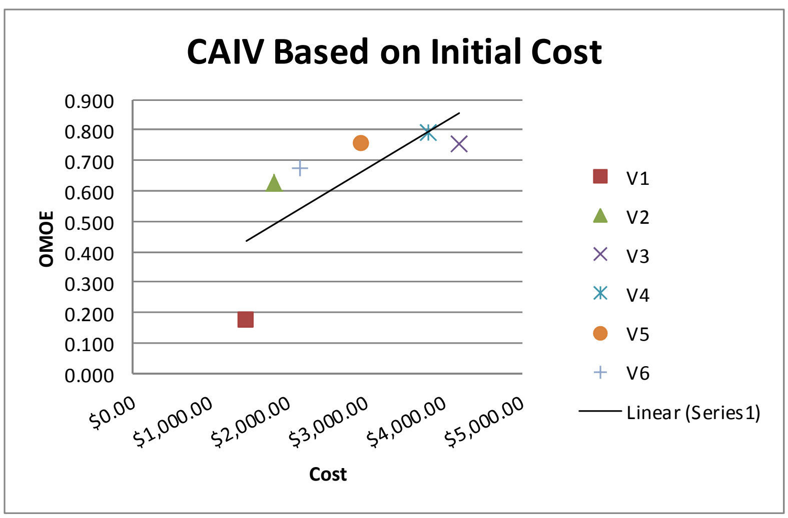


Figure 3-20 CAIV Results

Given the provided information provided by the CAIV, the two most advantageous solutions are Variant 2 and Variant 6. Variant 6 offers a higher level of overall performance when compared to stakeholder input at a slightly higher cost. The design team recommends selecting Variant 6 to maximize performance when compared to cost (see Table 3-33).

With this recommendation in mind, it is important to note that the HASS team elected to evaluate the most capable system. The team felt that it was important to evaluate all of the components. The systems recommend as being the best value in terms of cost, omit certain components that are required to meet objective levels of performance, but not required to meet the threshold requirements established by the stakeholders.

4. Test and Evaluation Strategy

As described in Section 3, the analysis of alternatives resulted in a prototype shelter system made up of components selected from categories including communication equipment, food storage equipment, water distribution equipment, and the shelter structure itself. The components were selected based on reported performance compared to item cost. The selection process did not include government testing which is required to verify the performance of each component and the system as a whole. This section describes the test concept, detailed test plan, and the results of the HASS testing.

4.1 Test Concept

Section 4 of the System Specification describes testing methods for all of the HASS requirements. However, since the HASS project was being conducted as a rapid prototyping effort, it was not possible to fully test all requirements of the system. For example, there was not sufficient time or resources to test durability requirements with any credibility. As another example, budgetary and time constraints allowed the purchase of one radio for the HASS prototype, but full-scale testing would require several radios, costly transmitters, and trained personnel.

As a result, a plan was developed to conduct an abbreviated test. Based on this initial testing, further refinement of the prototype will occur. In the future, full-scale testing will be needed.

Despite not being able to fully test every requirement, resources were available in terms of equipment and expertise to conduct very thorough testing of many system requirements. To do this most effectively necessitated breaking up the testing among different teams. Five team members are located in Virginia, therefore most components, including the shelter structure, were tested in Virginia. Due to local expertise and appropriate test equipment, one HASS team member conducted testing of components associated with food preparation and water storage utilizing facilities and equipment at his place of work in Massachusetts. For this reason, there are separate test results documents from each testing effort. These are available in Appendix H.

For the testing in Virginia, Marine Corps Systems Command in Quantico, Virginia, donated warehouse space, a site for set-up and testing of the shelter structure, and equipment such as a forklift and a shipping container.

4.2 Test Planning

The tests to be conducted were described in a Detailed Test Plan, which is included in Appendix G. For each test, there is a preparation section that describes things that need to be accomplished before the test begins, such as selection of a test site with certain parameters, or accomplishment of pre-test set-up. There is an equipment section that lists equipment or supplies needed to conduct the test. Finally, the individual steps of each test procedure are shown in table form, with a second column clearly indicating the need for recorded results or data.

The Detailed Test Plan also includes a table showing each requirement identified in the system specification for the HASS. The table indicates whether our abbreviated test plan provides full testing, partial testing, or no testing at all for each given requirement. Section 4 of the system specification provides further details about test methods and requirements for future full scale testing.

4.3 Test Results

Three separate test reports document the testing that was conducted. These are included in Appendix H. Each report contains photographs of the testing in progress and analysis and evaluation of the test data.

The initial HASS prototype successfully passed a majority of the tests conducted. Areas of testing in which the HASS did not sufficiently meet requirements include:

- Requirement 3.4.2.1, Material Sources: Without some design changes, the HASS does not adequately support use of locally available materials in construction. Design changes would likely be minor.

- Requirement 3.4.15.6, Vector-Born Disease: The current HASS design meets this requirement everywhere except at the bottom of the two doors. A design change is needed to fully meet this requirement.

Areas in which the HASS did not meet objective requirements, but met threshold requirements, include:

- Requirement 3.3.2, Operating Terrain: Although the system is not capable of being leveled, it still could likely operate on somewhat uneven terrain. This is certainly not the ideal set-up, and for practical purposes, those erecting the shelter should seek a level site for construction.

Areas in which the HASS technically met requirements, but not sufficiently in our estimation, include:

- Requirements 3.4.11.1, Divider Volume Division, and 3.4.10, Artificial Lighting: Although these requirements are fully met if the HASS is used without the liner, use of the liner is desirable but incompatible with these requirements. Therefore, improvement is needed in this area.

Full-scale testing may reveal further deficiencies. However, none of these seem like insurmountable problems. Ultimately, the HASS prototype performed well in initial testing.

Based on test results and observations made during testing, we recommend several minor modifications to the HASS prototype. These include:

- Improve the design so that the frame can be leveled without interfering with the floor.
- Pre-drill attachment points for locally available building materials during manufacture.
- Pre-drill holes for attaching the included corner braces.
- Include a pair of tin-snips or similar tool per six or seven shelters in order to unpack the frame from its shipping configuration.
- Redesign the liner so that reinforced holes provide access to the frame for attaching lighting and the divider.

- Select an alternate, more durable, set of pots and pans.
- Select an alternate water filter system with greater durability.
- Select an alternate set of food storage containers with more durable lids.
- Consider reducing the required output from the artificial lighting. (This is a requirements change; the selected lighting performed adequately, but the requirement may be too stringent.)

Further details are available in the test results documents in the appendix, but overall, the HASS performed very well in our testing.

5. Risk

The team documented the results of ongoing risk assessments for the program. The objective of this work was to prioritize the most significant risks and to identify their respective mitigation actions. The team gathered risk inputs from the team members, stakeholders and advisors to provide the most comprehensive risk assessment possible. The risk assessment characterized each risk in terms of program or technically related risks. Program risks were defined as risks that would have impact to the schedule of the program if the risk was realized, while technical risks were defined as risks that have impact to the performance if the risk was realized.

Each risk was rated by its probability of occurrence: Highly Unlikely, Unlikely, Possible, Likely, or Highly Likely as shown in Table 5-1. Similarly, the impact of the risk, if realized, is rated as Low, Minor, Moderate, Significant, or Severe as shown in Table 5-2. Evaluation of the risks was based on data collected from subject matter experts. Using the probability of occurrence and the impact, an overall risk level was identified. Definition of the rating system and the associated color code assigned for the different ratings are shown in the risk summary matrix (Figure 5-1) and in Table 5-3.

Table 5-1 Likelihood Calculation

Likelihood

Level	Likelihood	Probability of Occurrence
1	Not Likely	~10%
2	Low Likelihood	~30%
3	Likely	~50%
4	Highly Likely	~70%
5	Near Certainty	~90%

Table 5-2 Consequence Calculation

Level	Technical Performance	Schedule	Cost
1	Minimal or No Consequence to Technical Performance	Minimal or No Impact	Minimal or No Impact
2	Minor reduction in technical performance or supportability, can be tolerated with little or no impact on program	Able to meet key dates Slip < * Weeks	Budget increase or unit production cost increases < ** (1% of Budget)
3	Moderate reduction in technical performance or supportability with limited impact on program objectives	Minor schedule slip. Able to meet key milestones with no schedule float Slip < * Week(s) Sub-system slip > * week(s) plus available float	Budget increase or unit production cost increase < ** (5% of Budget)
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success	Program critical path affected Slip < * Week(s)	Budget increase or unit production cost increase < ** (10% of Budget)
5	Severe degradation in technical performance; Cannot meet KPP or key technical/supportability threshold; will jeopardize program success	Cannot meet key program milestones Slip > * Week(s)	Exceeds APB threshold > ** (10% of Budget)

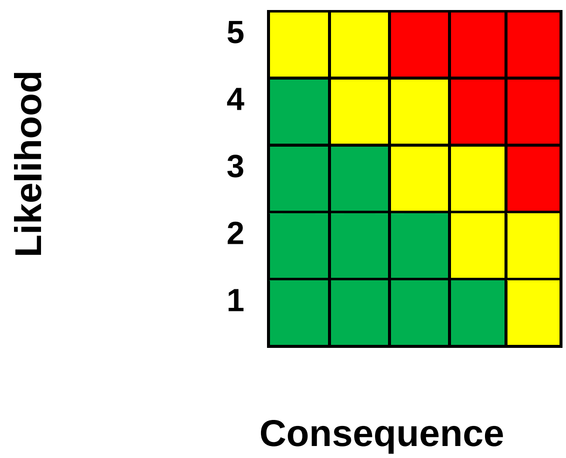


Figure 5-1 Risk Summary Matrix

Once the risks were characterized, priorities were assigned based on their relative probability and impact ratings to facilitate management and handling of these risks. The green boxes in Figure 5-1 identify the low priority level risks, yellow boxes indicate medium level risks while the red boxes identify the risks that warrant higher priority for handling and management. The impact of the risk level is outlined in Table 5-3 below.

Table 5-3 Risk Level Impact Definition

High	Likely to cause significant serious disruption of schedule, increase in cost, or degradation of performance even with special contractor emphasis and close government monitoring.
Moderate	Can potentially cause some disruption of schedule, increase in cost, or degradation of performance. However, special contractor emphasis and close government monitoring will probably be able to overcome difficulties.
Low	Has little potential to cause disruption of schedule, increase in cost, or performance. Normal contractor effort and normal government monitoring will probably be able to overcome difficulties.

Table 5-4 below lists those risks identified for the program along with potential consequences. Risk mitigation actions were proposed for each of the identified risks and provided to the stakeholders for evaluation. Priorities for mitigation actions were assigned based on impact level with the highest impact items on the top of the list down to the lower risk items.

Table 5-4 Risk Items

Item	Type	If	Then	Likelihood	Consequence	Impact Level	Mitigation
1	Program	If requirements creep happens due to lack of initial contact from stakeholder	all documentation will have to be updated to reflect the changes.	3	4	Moderate	Freeze MNS based on current level of stakeholder feedback.
2	Program	If the team does not accurately record and implement the planned schedule	the project will run late	4	4	High	Provide timely and accurate status report to scheduler for proficient tracking
3	Program	If MOEs and TPMs cannot be defined as measurable and reasonable within the scope of the effort	then verification of all MOEs and TPMs will not be able to occur	3	3	Moderate	Ensure the MOEs and TPMs are defined as measurable
4	Program	If prototype system not identified early in schedule	then procurement of necessary materials and equipment for prototype development may not meet schedule	3	4	Moderate	There is little margin for slip in the schedule. Ensure the prototype system is identified in accordance with the schedule
5	Program	If TRUE stakeholders of the transitional HASS are not identified and information solicited	then the technical solution provided by the cohort may result in a solution that does not meet real world needs (becomes purely an academic exercise)	3	4	Moderate	Leverage the faculty to identify and agree to TRUE stakeholders
6	Program	If the HASS is too expensive	then NGOs will not be buy the units	2	4	Moderate	Establish a price to win and weigh component performance vs cost (CAIV) to meet price
7	Program	If the HASS's requirement are too strict	then COTS components may not meet them	3	3	Moderate	Develop realistic requirements which can be met by COTS solutions
8	Program	If the HASS system components do not arrive in time for testing	testing will not be completed in time to complete final report	4	4	High	Test available items in parallel. Do not wait for all items to arrive.
9	Program	If testing is not completed in time	the final report will be incomplete	3	4	Moderate	Complete test plan within schedule allotment
10	Program	If the final report sections are not completed early	then the final report will not be completed with adequate time for advisor review	2	4	Moderate	Complete initial assigned inputs by 7/25
11	Technical	If the concept of operations is incorrect or incomplete in its assumption	certain capabilities may be overlooked, limiting the HASS' operational effectiveness	1	4	Low	Keep in constant contact with our stakeholders as well as continuously perform background research to ensure a thorough understanding of the general operational concept

Item	Type	If	Then	Likelihood	Consequence	Impact Level	Mitigation
12	Technical	If there is insufficient funding to procure, assemble, and test a prototype system	the system's functionality, safety, and transportability will not be verified	3	3	Moderate	Ensure that funding is available early on from NPS. Look for possible alternate sources of funding. Maximize the use of COTS equipment and prioritize materials and components for procurement which have a direct and crucial effect on testing the system's functionality, safety, and transportability
13	Technical	If requirements are incorrectly captured or missed	the project may not meet the stakeholder's needs	3	3	Moderate	Trace requirements to mission need statement thereby verifying stakeholder's needs as assessed by the leadership
14	Technical	If the HASS is not verified in accordance with the system spec	then ECP's will be required to meet requirements	5	2	Moderate	Perform as many verifications as practical via component testing. Verifications which cannot be completed will be pushed to the ensuing team

Fourteen risks were identified, ten were programmatic in nature and four were technical. Of all the risks, only two were identified as high-risk items; both were programmatic and were mitigated and closed by the team. Due to time constraints, it was not possible to completely mitigate risk item 14. It is the only risk item that remains open at the conclusion of the program; as a moderate technical risk, the team accepts the risk and will forward the mitigating actions to the next phase of the program. Not all verifications of the HASS system specification could be performed. However, the team tested as many components are practical and will forward the test data to the next team for evaluation and for further testing if required. The accepting team will then be required to complete testing and verification as identified in Section 4.3.

6. LIFE CYCLE COST ESTIMATE

6.1 Methodology

A Life Cycle Cost Estimate (LCCE) is a programmatic tool used to evaluate the potential cost of a system over its lifetime. (DAU - Ask A Professor n.d.) The DoD has identified four LCCE phases: (1) research and development (R&D) includes development and design costs for system engineering and design, test and evaluation, and other costs associated to design of the system; (2) investment or procurement (I&P) includes total production and deployment costs for the system and all support equipment and facilities; (3) operation and sustainment (O&S) includes direct and indirect costs incurred in using the system; and (4) disposal costs. The LCCE is used at major decision points when making decisions between different design options.

6.2 Results and Analysis

The cost estimates completed for this portion of the project were used to make a decision between six different prototype options. A tiered approach was taken when creating the system variants. The design choices ranged from a “least capable” system which met the design thresholds to the “most capable” system which met all of the design objectives. Cost data was associated to each component comprising the six variants in order to create a basis for the CAIV analysis. These variants can be seen in Table 6-1 along with the cost for each component.

Several assumptions were made in conducting the LCCE based on the HASS’s unique program requirements. Due to the limited time and nature of this effort, the R&D was performed by the commercial developers of the HASS components. The design team conducted market research to procure the components which met the system requirements. Because the components of the HASS are all Commercial-off-the-shelf, it was also assumed item costs were relatively fixed. The HASS’s operational concept was to deploy the HASS and leave it in place. The system has minimal operations and sustainment costs. The main operational cost driver is associated to shipping (D'Lugos 2011) the HASS in the event of a natural disaster. The HASS is

considered to be a "remain-in-place" item; therefore the HASS program will not incur any disposal costs.

Table 6-1 Component Cost Estimates

Component	R&D Cost	I&P Cost	O&S Cost	Disposal Cost
Shelter	$0.00	$1,350.00	$0.00	$0.00
Water Storage and Distribution	$0.00	$275.00	$0.00	$0.00
Food Preparation	$0.00	$165.00	$450.00	$0.00
Food Distribution	$0.00	$129.35	$0.00	$0.00
Food Storage	$0.00	$15.68	$0.00	$0.00
Water Purification	$0.00	$160.00	$700.00	$0.00
Communications	$0.00	$56.50	$0.00	$0.00
Lighting	$0.00	$225.00	$50.00	$0.00
Total Lifecycle Cost	$0.00	$2,376.53	$1,200.00	$0.00

Table 6-2 Shipping Cost Estimates

Shipping Container	**Destination**	**Shipping Method**	**Shipping Rate**
Pallet	Asia	Air	lbs per pallet X # of pallets X $1.69 lb = Shipping Cost
Pallet	Pacific Islands	Air	lbs per pallet X # of pallets X $1.40 lb = Shipping Cost
Pallet	CONUS	Ground	46 pallets per truck = full truck price of $4070

The LCCE is and will remain incomplete until a decision for the number of required systems is made. Once this decision point is established, the total cost of the program may be established. An example program cost for 10,000 units has been provided in Table 6-3 below.

Table 6-3 LCCE for 10,000 Fielded Units

Component	Procurement Cost	Investment Cost (10000 systems)	O&S Cost	Disposal Cost
Shelter	$1,350.00	$13,500,000.00	$0.00	$0.00
Water Storage and Distribution	$275.00	$2,750,000.00	$0.00	$0.00
Food Preparation	$165.00	$1,650,000.00	$4,500,000.00	$0.00
Food Distribution	$129.35	$1,293,500.00	$0.00	$0.00
Food Storage	$15.68	$156,800.00	$0.00	$0.00
Water Purification	$160.00	$1,600,000.00	$7,000,000.00	$0.00
Communications	$56.50	$565,000.00	$0.00	$0.00
Lighting	$225.00	$2,250,000.00	$500,000.00	$0.00
Shipping Cost to Asia (5000)			$2,112,500.00	
Shipping Cost in Conus (5000)			$443,630.00	
Totals	$2,376.53	$23,376,530.00	$14,556,130.00	
Total Lifecycle Cost	$38,321,430.00			

The above table shows an average Life Cycle Cost per unit of $3832. This cost encompasses initial procurement as well as shipping of the system to its destination. Also included in this estimate are the replacement cost for the fuel for food preparation equipment, filter and purification media for the water purification component, and replacement light bulbs for the lighting component. Neither replacement batteries nor external are not required for either the communication component or the lighting component. The communication component is powered by and emergency power crank and the lighting component are solar powered.

7. Summary and Conclusions

7.1 Work to Date

This systems engineering team applied a tailored rapid prototyping system engineering model to the HASS system. The team successfully applied the processes from problem definition to candidate testing of the engineering model for the HASS system. The team identified individual candidate solutions for each physical architecture components of the HASS system. From those candidate solutions for each individual physical architecture component multiple candidate solution systems were developed linking capability provided to a range of price points from $916.00 to 3,535.00. Finally, limited testing was performed on the candidate solutions against the requirements defined in the HASS System Specification.

7.2 Conclusions

This project successfully applied a system engineering process model with a documentation package to define and develop a solution to a transitional shelter need for HA/DR efforts. This project ended with development of multiple possible candidate solution systems based upon price points that can be further evaluated to meet individual stakeholder needs. It is recommended that continued effort be placed on further definition and development of the transitional shelter with this project providing a jumping off point based upon the detailed specification and testing requirements for a transitional shelter system. This project is not meant to be an end solution to the problem but rather provide a guide for future efforts and research into this area.

7.3 Critical issues

The team acknowledges there are still a number of critical issues either identified or created as part of this project.

- In development of candidate solutions the price points developed were the result of individual research into candidate solutions with priority on meeting individual physical

architecture component requirements and not price point. It is possible cheaper components exists within the trade space of requirements and price of those components.

- Testing of the HASS system was limited in not only scope and breadth but time available; as a result, complete testing of the HASS system to all validation efforts in Section 4 was not performed. The assumption based upon research was that the individual component solutions were able to meet the requirements defined; however, thorough testing to verify and validate the assumption was not completed as part of this project.

- The fielding and maintenance of the HASS system was considered as part of this project along with a full lifecycle cost. However, the implementation of the plans developed may not be complete or thorough enough for actual acquisition due to limited information or assumptions made to support this effort.

- Reliability and maintenance calculations were based upon assumptions determined by the project team to be best estimates. Actual reliability/preventive and corrective maintenance data needs to be acquired from actual field tests/user evaluations to accurately determine necessary reliability and maintenance performance requirements.

7.4 Future Work

This effort produced candidate solutions based upon defined and documented requirements that were developed. However this effort can be considered a jumping off point for possible future work to include but not limited to:

- Complete testing of the HASS to all Section 4 validation requirements of the HASS System Specification. The complete testing of all Section 4 validation requirements was not performed as part of this effort due to limited time and resources.

- Field testing or limited user evaluation should be considered to help refine the solution to ensure the system will work as planned and all issues of fielding the system have been captured. Possible design changes may be necessary based upon field testing and/or a limited user evaluation.

- From the teams' communication with stakeholders of the HASS, it was discovered that in most cases the transitional shelter is used as the source and basis for a permanent shelter solution by the inhabitants. Research and testing needs to be performed to determine what materials and components can be integrated into the HASS in order for it to transition into a permanent shelter solution. Furthermore, the current frame design needs to be evaluated to determine if it is effective at being able to be integrated with locally available materials. A finite element analysis simulation should also be run on the frame to determine if it can handle the severe operational environment requirements stated when integrated with locally available materials.

- From the teams communication with stakeholders of the system it was discovered that in most cases the materials used to construct the shelters are acquired from within the country of the disaster. Research and testing into possible replacement materials for components of the system needs to be done to determine which Critical Construction Components (CCCs) are likely going to be available for construction of the shelter from the local community in various scenarios.

7.5 Final Thoughts

As a result of this project a HASS was successfully developed and can be traced back to requirements generated from multiple stakeholders. This design effort, based off a joint requirements set from both Navy and USAID stakeholders, offers for the first time a HASS solution which meets customer needs and integrates with both stakeholders' CONOPS in relevance to logistics as well as implementation. This joint assistance in the HASS' developmental efforts is sure to ensure a smoother acquisition, implementation, and integration process with current Humanitarian Aid/Disaster Relief efforts being conducted by both stakeholders.

For future efforts, documents were created; such as a complete and thoroughly traced system specification; a CONOPS based off of multiple meetings with real relevant stakeholders; and a maintenance concept reflective of the CONOPS. While limited testing of the system was performed, further testing will most definitely need to be performed in order to validate all

requirements for the HASS. This project provides a well documented and structured first attempt at defining and developing a coordinated and effective solution to a prepackaged system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and subsequent permanent housing.

APPENDIX A: PROJECT MANAGEMENT PLAN

SE311-101O Capstone Project

Project Management Plan

for

Shelter Options for Humanitarian Assistance

V 2.0

03/18/2011

Advisors

Dr. David Olwell – Brigitte Kwinn

Team Leader

Ben Williams

PROJECT MANAGEMENT PLAN (PMP)

FOR THE

SHELTER OPTIONS FOR HUMANITARIAN ASSISTANCE PROJECT

V 2.0

03/18/2011

PMP Approvals:

______________________________	____________
Program Manager – XXXX	**[Date]**
______________________________	____________
Product Group Director (PGD)	**[Date]**
______________________________	____________
Assistant Commander for Programs (AC-PROG)	**[Date]**

PREFACE

The shelter options for humanitarian assistance project focuses on one aspect of Humanitarian Aid/Disaster Relief (HA/DR), which is the provision of shelter to distressed persons or victims of a disaster. Currently, the U.S. Government does not have a shelter system in place specifically designed to support (HA/DR) operations. The purpose of this capstone project is to discover and analyze possible Humanitarian Assistance Shelter System (HASS) concepts by utilizing systems engineering tools and techniques. This will allow the capstone project group to make an informed suggestion to the system's stakeholders as to which system(s) concept will best meet their needs. At a minimum the system will provide shelter to the user for a pre-determined period of time. Additional capabilities may be provided based upon customer requirements, but may be constrained due to funding limitations. Some of these additional capabilities may include HVAC, food preparation and storage, water purification and storage, sanitation, hygiene, communication, and improved setup/logistical capabilities.

RECORD OF CHANGES

*A - ADDED M - MODIFIED D – DELETED

VERSION NUMBER	DATE	NUMBER OF FIGURE, TABLE OR PARAGRAPH	**A* M D**	TITLE OR BRIEF DESCRIPTION	CHANGE REQUEST NUMBER
1.0	02/09/11			Original. This is the original document as initially written.	PP-0001
2.0	03/18/11				

Table of Contents

List of Figures

List of Tables

1. Project Overview & Description

1.1 Overview

Naval Postgraduate School distance learning cohort 311-101O has selected the topic of Shelter Options for Humanitarian Assistance (HASS) for our Capstone Project to be conducted over the course of the next three quarters. This document will provide the details of how we plan to execute this Capstone Project. Sections that follow will provide specific details such as a description of the project, project schedule and milestones, problem identification and mission needs statement, any constraints, dependencies and assumptions, team organization, management processes, our technical approach, and methods, tools and techniques.

The selection of this topic is, in part, due to the major developments in recent history such as the tsunamis in Indonesia in 2004, Hurricane Katrina laying waste to the United States' Gulf Coast in 2005, and the devastating earthquake in Haiti in 2010. It was also selected due the substantial involvement of not only the US Navy, but also other government and non-governmental organizations (NGOs) in the response effort for these domestic and international natural disasters.

1.2 Description

The shelter options for humanitarian assistance (HASS) project focuses on one aspect of Humanitarian Aid/Disaster Relief (HA/DR) which is the provision of shelter to distressed persons or victims of a disaster. Currently, the US Navy, one of world's leading HA/DR agencies, does not have a shelter system in place specifically designed to support operations which would require a HASS. The purpose of this capstone project is to discover and analyze possible HASS shelter concepts by utilizing systems engineering tools and techniques. This will allow the capstone project group to make an informed suggestion to the US Navy and other system stakeholders as to which system(s) concept will best meet their needs.

2 Applicable Documents

2.1 Market Research Document HTTP Links

- http://inhabitat.com/emergency-shelters-and-disaster-relief-for-the-people-of-haiti/
- http://inhabitat.com/prefab-friday-reaction-housing-emergency-shelters/
- http://www.atcosl.com/en-ca/Products-and-Services/Industry/Defense.htm?gclid=CJ_wwdmK46YCFRVx5QodxG3Q2g
- http://worldshelters.org/shelters
- http://openarchitecturenetwork.org/projects/%5Bfield_oanproject_path-raw%5D-4
- http://calearth.org/building-designs/emergency-sandbag-shelter.html

2.2 Configuration Management Documents

- National Standards Institute/Electronic Industries Alliance-649 [1998]

- Military Handbook-61A (SE) [2007]
- The Defense Acquisition Guidebook [2006] Chapter 4, section 4.2.3.6.

2.3 Quality Assurance Documents

- ISO 9000 - http://www.iso.org/iso/iso_9000_essentials
- ISO 10006:2003 http://www.iso.org/iso/catalogue_detail.htm?csnumber=36643

2.4 Technical Reference Documents

- Systems Engineering for Rapid Prototyping: Friendly Marking Device", Major Monte Cannon, Major Greg Buckner, Major Greg Buttram, Major Michael Jiru, Major Arlene Collazo, Dr Rich Cobb, Dr John Colombi, Air Force Institute of Technology, 9th SE Conference, Oct 2006
- INCOSE SE Handbook v3.1
- Mil-Std 882, Standard Practice for System Safety

3 Milestones, Deliverables & Schedule

3.1 Milestones

The Milestones are anchored in tasks set by the advisors and have little flexibility. They are listed in **Table 1** below. Each milestone event generates a deliverable product.

Table 1: Milestones

Task	Date
PMP Due	11 Feb 2011
IPR #1	18 Mar 2011
IPR #2	10 Jun 2011
Final Report Due	26 Aug 2011
Final Presentation Due	9 Sep 2011

3.2 Deliverables

In addition to the documents delivered for each milestone, the prototype system will be delivered at the conclusion of this project.

3.3 Schedule

Shown below in Figure 1 is the preliminary schedule of major accomplishments and milestones for the project. More in-depth schedules will be developed throughout the project as individual objectives are

broken down into their constituent tasks. A more comprehensive tentative WBS, which the schedule is based upon is available in Appendix A.

4 Problem Identification

4.1 Problem Statement

A capability gap exists in humanitarian shelters as there is not a prepackaged system that can be stored and then delivered to disaster victims easily and quickly when necessary. Currently, the U.S Government does not have a shelter system in place specifically designed to support Humanitarian Assistance (HA) and Disaster Relief (DR) operations. In order to support the future U.S Government humanitarian mission, shelter options and alternative shall provide a reliable, deployable, survivable and maintainable system to the user.

In the last ten years, a number of epic disasters have struck the Earth displacing millions of people and eliminating even the most basic of amenities. Electricity, food, clean water, shelter and medical care are instantly wiped out and become critical needs. The United States Government is typically a first responder in these events. However there is currently no standard shelter system in place specifically designed to support HA/DR operations. The primary functions of the HASS s are to protect the disaster victims from the natural elements and to provide habitable shelter. Secondary functions may include food preparation and storage, water purification and storage, sanitation, hygiene, communication, and improved setup/logistical capabilities.

The shelter will be used in a variety of operational environments and will need to accommodate the variety of conditions. The shelter must be capable of supporting occupants and should provide adequate function. The shelter must be readily deployable from current government assets and must be capable of interfacing with standard government transportation interfaces. Shelter from the elements is one of the most basic needs that inhabitants of a third world disaster area will require. This system would serve as a rapidly deployable form of aid to the inhabitants of the affected areas.

4.2 Mission Need Statement (MNS)

A comprehensive preliminary MNS is available in Appendix B. This preliminary MNS was developed through extensive background research, which was utilized in determining specific stakeholder needs. This preliminary MNS was also used in the generation on a preliminary Functional Analysis (FA). Both the MNS and FA are subject to change as stakeholder needs are refined and changed throughout the course of the project.

ID	Task Name	Duration	Start	Finish
1	**Disaster Shelter Project**	**186 days**	**Fri 1/7/11**	**Fri 9/23/11**
2	**Program Management and Reviews**	**176 days**	**Fri 1/7/11**	**Fri 9/9/11**
3	**Program Management Plan**	**26 days**	**Fri 1/7/11**	**Fri 2/11/11**
7	**In Process Reviews**	**75 days**	**Mon 2/28/11**	**Fri 6/10/11**
8	**IPR # 1**	**15 days**	**Mon 2/28/11**	**Fri 3/18/11**
12	**IPR # 2**	**15 days**	**Mon 5/23/11**	**Fri 6/10/11**
16	**Final Report & Presentation**	**159 days**	**Tue 2/1/11**	**Fri 9/9/11**
17	Final Report Development	140 days	Tue 2/1/11	Mon 8/15/11
18	Final Report Review	5 days	Tue 8/16/11	Mon 8/22/11
19	Final Report Due	0 days	Fri 8/26/11	Fri 8/26/11
20	Final Briefing Development	10 days	Mon 8/22/11	Fri 9/2/11
21	Final Briefing Review	4 days	Mon 9/5/11	Thu 9/8/11
22	Final Briefing Due	0 days	Fri 9/9/11	Fri 9/9/11
23	**System Engineering Management Plan**	**25 days**	**Fri 2/11/11**	**Thu 3/17/11**
24	Draft SEMP	17 days	Fri 2/11/11	Mon 3/7/11
25	Review SEMP	8 days	Tue 3/8/11	Thu 3/17/11
26	Deliver SEMP	0 days	Thu 3/17/11	Thu 3/17/11
27	Risk Management	180 days	Fri 1/7/11	Thu 9/15/11
28	Graduation	0 days	Fri 9/23/11	Fri 9/23/11
29	**Technical**	**146 days**	**Fri 1/7/11**	**Fri 7/29/11**
30	**Conceptual Design Tasks**	**61 days**	**Fri 1/7/11**	**Fri 4/1/11**
31	Background Research	31 days	Fri 1/7/11	Fri 2/18/11
32	Identify Stakeholders	14 days	Fri 1/7/11	Wed 1/26/11
33	Develop Statement of Needs/Problem	21 days	Fri 1/7/11	Fri 2/4/11
34	**Functional Analysis**	**40 days**	**Mon 2/7/11**	**Fri 4/1/11**
41	**System Requirement Specification**	**25 days**	**Fri 2/18/11**	**Thu 3/24/11**
45	Develop Operational Concept	10 days	Mon 2/7/11	Fri 2/18/11
46	Develop Requirements	10 days	Mon 2/21/11	Fri 3/4/11
47	Develop Maintenance & Support Concept	10 days	Mon 3/7/11	Fri 3/18/11
48	Conceptual Design Review	1 day	Fri 3/18/11	Fri 3/18/11
49	Get Approval for Concept Design	0 days	Fri 3/18/11	Fri 3/18/11
50	Write up Conceptual Design for Final Re	5 days	Mon 3/21/11	Fri 3/25/11
51	**Preliminary Design Tasks**	**27 days**	**Tue 3/29/11**	**Wed 5/4/11**
59	**Detailed Design Tasks**	**16 days**	**Thu 4/28/11**	**Thu 5/19/11**
67	**Procure & Integrate Hardware**	**16 days**	**Thu 5/12/11**	**Thu 6/2/11**
72	**Test & Evaluation**	**27 days**	**Thu 6/23/11**	**Fri 7/29/11**
73	Perform Test Planning	5 days	Thu 6/23/11	Wed 6/29/11
74	**Perform Testing**	**17 days**	**Thu 6/30/11**	**Fri 7/22/11**
79	Write up Test & Evaluation for Final Repo	5 days	Mon 7/25/11	Fri 7/29/11
80	Package and Delivery Prototype	10 days	Mon 8/1/11	Fri 8/12/11

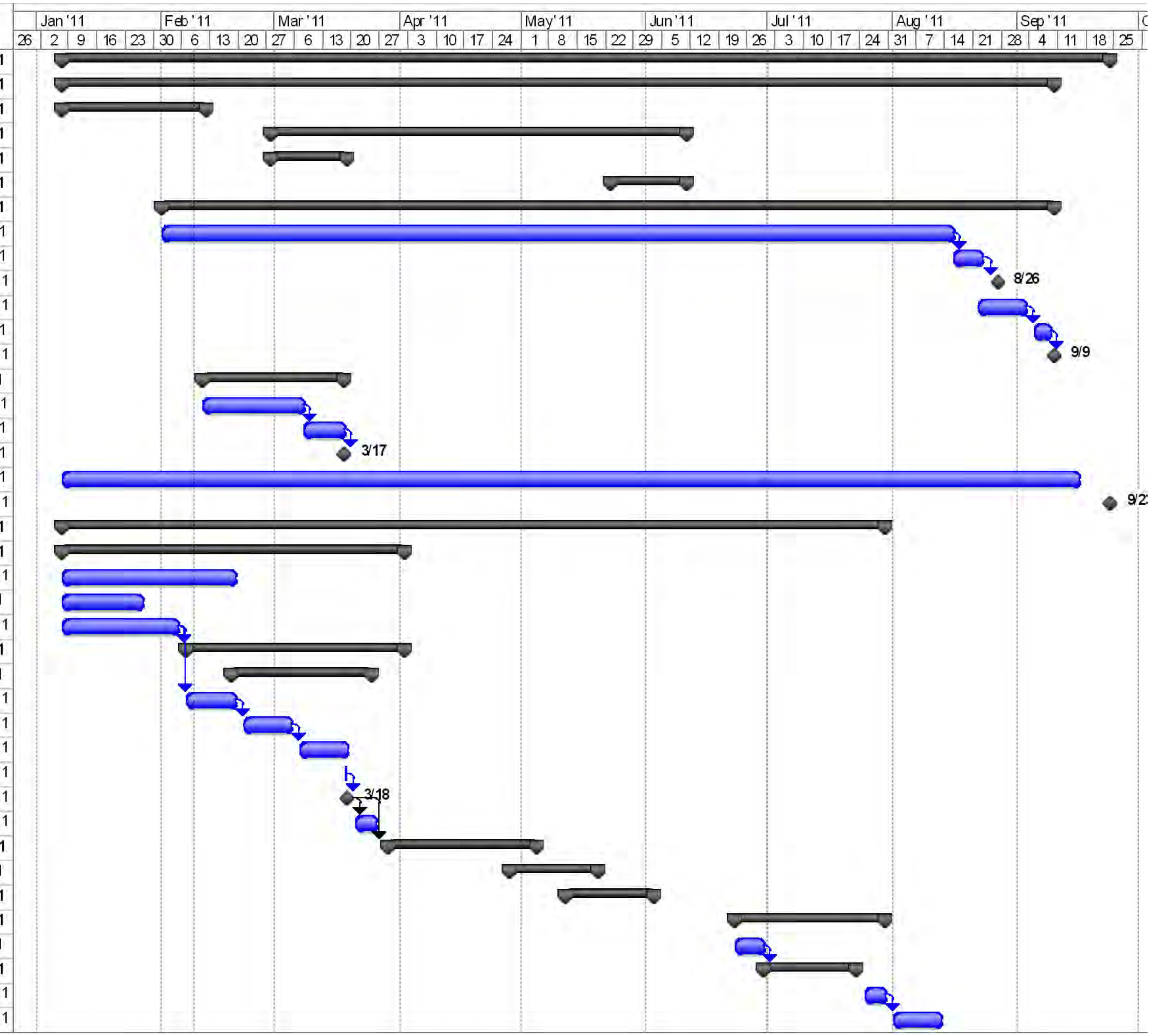


Figure 1: Preliminary Schedule

5 Constraints

- Eight months are available for completion of the project
- Stakeholders will have limited availability to support the execution of the SE 311-101O Capstone Project. Opportunities to elicit feedback will be few and must therefore be well planned to ensure necessary feedback is obtained.
- Limited funding is available to support procurement of identified components.

6 Dependencies

- Dependencies will be observed between defined schedule activities
- Dependencies will be observed between management processes
- Dependencies will be observed between technical processes
- Prototypical operational requirements and concepts of operation must be available for Stakeholders to acknowledge or object to
- Priorities between acknowledged system operational requirements must be elicited from Stakeholders to facilitate performance of analysis

7 Assumptions

- The SE 311-101O Capstone Project Team will define and baseline a schedule consistent with this PMP.
- The SE 311-101O Capstone Project Team will execute to that schedule.
- The SE 311-101O Capstone Project Team will "status" the progress of scheduled activities on a periodic basis.
- Risk and Opportunity Management will be actively performed per PMP guidance to support cost, schedule and requirements basement control.
- If decisions are made to change course from executing activities as defined in the baseline project schedule, then the schedule baseline will be formally changed to ensure all members of the team are cognizant of the change in direction and can adjust their project activities accordingly. Similar change control measures will be performed for changes to the requirements and cost baselines.
- No additional funding will be made available with which to support procurement of shelter components

8 Organization

8.1 Students

A list of the students participating in this project along with their current time zone and contact email can be seen below in Table 2. A description of their background professional field is also listed.

Table 2: Student Participants

Name	Email	Time Zone	Background Professional Field
Bidigaray, Stefan	smbidiga@nps.edu	CST	Mechanical Engineer/System Engineer
Brar, Jaspal	jsbrar@nps.edu	EST	
Fiery, William	wefiery@nps.edu	EST	Surface Warfare Officer/Mission Analyst
Hory, Dixon	dhory@nps.edu	CST	Psychology/Business Systems Consultant/Systems Engineer
Jarabak, Eric	ejarabak@nps.edu	EST	Computer Engineer/Computer Science/System Engineer
Kemmey, Whitney	wwkemmey@nps.edu	EST	Computer Science/Programmer
Lee, Paul	plee@nps.edu	EST	Mechanical Engineer
McKinney, Janet	jgmckinn@nps.edu	EST	Computational and Applied Mathematics/Safety Analyst
Montes, Jose	jamontes@nps.edu	PST	Electrical Engineering/Nuclear Turbine Generators
Nguyen, Megan	mmnguyen@nps.edu	PST	Mechanical Engineer/Engineering Management
Seab, Joshua	jwseab@nps.edu	CST	Industrial Engineering
Thomas, Jacob	jathoma1@nps.edu	CST	Naval Architecture/Marine Engineering

Name	Email	Time Zone	Background Professional Field
Wareham, Jeffrey	jswareha@nps.edu	CST	Mathematics/Computer Science/System Engineer/IT
Williams, Benjamin	bswillia@nps.edu	EST	Mechanical Engineering/Design Engineer

8.2 Advisors

A list of the advisors and organizers participating in this project is listed below in Table 3.

Table 3: Advisor and Organizer Participants

Name	Position	Email	Time Zone
Burns, Daniel	**Organizer**	dpburns@nps.edu	**PST**
Hahn, Heather	**Organizer**	hlhahn@nps.edu	**PST**
Kwinn, Brigitte	**Advisor**	btkwinn@nps.edu	**EST**
Olwell, David	**Advisor**	dholwell@nps.edu	**PST**

8.3 Stakeholders

A comprehensive list of stakeholders and users relevant to the HASS can be viewed below. At this point in time it has been determined that USAID, followed by the U.S. Navy, are our primary stakeholders. This is because these two organizations are the primary supporters during HA/DR operations.

Stakeholders

- Federal Government
  - President
    - Department of Defense
      - USN
      - US Army
      - USMC
      - US Air Force
      - Combatant Commands
        - PACOM

            - SOUTHCOM
            - CENTCOM
            - SOUTHCOM
            - NORTHCOM
        - Program Executive Officer
            - Program Management Office
    - Department of Homeland Security
        - FEMA
    - State Department
        - USAID
        - Peace Corps
    - Department of the Interior
        - National Park Service
- State and Local Government
    - Governors, County/Parish Presidents, Mayors
        - Emergency Management Agencies
        - Fire Departments
        - Police Departments
- Foreign Governments
- Non-Governmental Organizations
    - Red Cross
    - Red Crescent
- Vendors/Contractors

Users

- Disaster Victims
- Disaster Volunteers
- Disaster Response Organizations

8.4 Roles and Responsibilities

A list of each participating student and their roles/responsibilities can be seen below in Table 4. Work associated with a student's assigned roles and responsibilities is in addition to regular project work that is assigned. A list of advisor roles/responsibilities is also available in Table 5 below.

Table 4: Student Roles and Responsibilities

Name	Role	Responsibilities
Bidigaray, Stefan	Finance, Modeler	Manage team funds. Model simulations and/or 3D models.
Brar, Jaspal	Architect, requirements manager	Manage system architecture. Manages system requirements
Fiery, William	Editor	Edit documents upon completion of documents
Hory, Dixon	Finance Officer	Manage team finances
Jarabak, Eric	Secretary	Take meeting minutes, attendance, and notes as necessary
Kemmey, Whitney	Simulation, Blogging	Manage team blog, uploading useful links and information for the project. Model simulations and/or 3D models.
Lee, Paul	Architect	Manage system architecture changes
McKinney, Janet	Scheduler	Schedule meetings and create/manage project timeline for tasks.
Montes, Jose	Modeling/Simulation	Model simulations and/or 3D models.
Nguyen, Megan	Librarian	Upload documents as necessary. Compile document updates in forum into final document.
Seab, Joshua	Modeling/Simulation	Model simulations and/or 3D models.
Thomas, Jacob	Blogger	Manage team blog, uploading useful links and information for the project.
Wareham, Jeffrey	Architect, editor, requirements manager	Manage system architecture changes. Edit project documentation for spelling, grammar, and consistency. Manages System Requirements
Williams, Benjamin	Team Leader	Facilitate meetings. Assign tasks. Organize project. Manage and upload documents.

Table 5: Advisor Roles and Responsibilities

Advisor Roles and Responsibilities		
Name	**Role**	**Responsibilities**
Kwinn, Brigitte	Support Advisor	• Providing consulting and technical expertise to the student team. The initiation will primarily be on the part of the students. • Making sure that important approaches or sources of information are not overlooked. • Providing quality control of the final product, ensuring it meets Systems Engineering and NPS standards. • Verifying that the Project documentation clearly and adequately communicates the Project activities and outcomes to someone who is not closely involved with the work.
Olwell, David	Lead Advisor	• Assist in determining what Project topics are feasible for a team to accomplish in the time permitted at NPS. • Help to decide on a reasonable choice for Support Advisors. This choice is frequently dictated by the nature of the Project topic. If the Project requires a resource person in content areas in which the Lead Advisor is not an expert, the Lead Advisor may recommend one or more Support Advisors to assist. • Help to identify and contact Project sponsors, where appropriate. • Help to lay out a schedule of milestones showing what should be accomplished in relation to the time remaining. • Review and approve the Project Plan • Meet with student teams regularly to monitor progress and provide consultation and direction. • Examine the Project for soundness of analysis and conclusions and for the appropriateness of recommendations. • Review products resulting from the Project effort. • Review and critique the Project documentation in the SE Professional Report, offer suggestions for necessary revisions, and check for accuracy and completeness. • Determine if the Project has met minimum standards, and approve the Project as completed.

8.5 Schedule Assignments

Listed below in Table 6 are the current assignments for each team member based upon tasks outlined in the project schedule. These project tasks are for the time frame spanning Jan 7 to Feb 28. IPT team leads are in direct control of their corresponding tasks. All IPT supporters answer directly to the IPT team lead for specific tasks and directions.

Table 6: Assignments

Task Name	Start	Finish	Assigned To	Supporters
Conceptual Design Tasks	1/7/2011 8:00	3/22/2011 8:00		
Background Research	1/7/2011 8:00	2/18/2011 8:00		
Develop Statement of Needs/Problem	1/7/2011 8:00	2/5/2011 8:00		
Identify Stakeholders	2/7/2011 8:00	2/22/2011 8:00	Ben Williams	
Develop Mission Needs Statement	2/5/2011 8:00	2/20/2011 8:00	Jaspal Brar	
Identify Assumptions	2/5/2011 8:00	2/20/2011 8:00	Jeff Wareham	
Develop Operational Concept	2/12/2011 17:00	2/23/2011 17:00	JanetBenEvanJaspal	
Develop Operational Activity Hierarchy Diagram (OV-5)	2/23/2011 17:00	2/25/2011 17:00	JanetBenEvanJaspal	
Engage stakeholders and perform analysis on feedback	2/27/2011 17:00	2/28/2011 17:00	WhitIPTLead	Paul
Develop MOEs	2/28/2011 17:00	3/2/2011 17:00	WhitIPTLead	Paul
Prioritize TPMs (AHP Pairwise Comparison)	3/2/2011 17:00	3/5/2011 17:00	WhitIPTLead	Paul
Develop Maintenance & Support Concept	2/21/2011 8:00	2/27/2011 8:00	Stefan IPT Lead	Megan
Identify System Level Requirements	2/13/2011 8:00	2/21/2011 8:00	Jaspal IPT Lead	Ben, Jake,Josh
Identify System Level Functions	2/21/2011 8:00	2/25/2011 8:00	Jaspal IPT Lead	Ben, Jake,Josh
Refine/Decompose System Level Requirements	2/21/2011 8:00	2/25/2011 8:00	Jaspal IPT Lead	Jake,Josh
Develop System Functional Description (Hierarchical SV-4a & Functional Flow SV-4b))	2/25/2011 8:00	2/26/2011 8:00	Jacob IPT Lead	Dixon
Develop Operation Activity to System Function Traceability Matrix (SV-5a)	2/26/2011 8:00	2/27/2011 8:00	Jacob IPT Lead	Dixon
Develop System Requirements to	2/27/2011	3/1/2011 8:00	Jaspal IPT Lead	Jake,Josh

System Functions Traceability Matrix	8:00			
Develop Technical Metrics: MOPs. KPPs, KSA,etc	2/25/2011 8:00	2/28/2011 8:00	Josh IPT Lead	Ben

9 Management Processes

9.1 Startup

The Program Manager (PM) is responsible for cost, schedule, and risk associated to programs. Ultimately this means the PM is held accountable for the overall success of a program. In order to ensure success a strong, focused team must be assembled to address the nuances of the problem. The first of many important task of the Management Process is to define the problem and the scope of the work. In defining these elements, the team will begin to formulate goals to work toward inside of an understood framework. Once the management understands the scope of the project, a team must be assembled and roles assigned to each member of the team to ensure success. Table 4 is a list of roles which have been assigned to team members.

In addition to the roles shown in Table 4, the management must assign members to and establish applicable IPTs in order to ensure program success. The main IPT which all members will be a part of is the Systems Engineering IPT. The SE IPT forms the top of the table which is supported by many legs. Our SE IPT is further divided into supporting elements or “legs” of the SE table. The Architecting IPT exists to decompose the requirements and provide functional allocation to elements of the system. The Supportability IPT exists to plan for employment, maintenance, storage, and transportation of the system. The Configuration IPT exists to manage the configuration of the elements of the system and to ensure effective integration of all system elements. The Risk IPT exists to identify, analyze, and control/mitigate risks associated to the program. A table showing the members of the corresponding IPTs can be seen below in Table 7.

Table 7: Systems Engineering IPTs

Systems Engineering IPT			
Architecting IPT	Supportability IPT	Configuration IPT	Risk IPT
• TBD	• TBD	• TBD	• TBD

9.2 Risk and Opportunity Management

The team will document the results of a risk and opportunity assessment for the program. The objective of this work will be to prioritize the most significant risks and opportunities and identify their respective mitigation actions. The team will take risk input from all stakeholders and team members to provide the most comprehensive risk assessment possible. A preliminary list of risks is included at Appendix C.

9.2.1 Risk Assessment

The risk assessment characterizes each risk in terms of schedule and/or technically related risk. Schedule risks are defined as risks that would have impact to the schedule of the program if the risk is realized, while technical risks are defined as risks that have impact to the TG performance if the risk is realized.

Each risk is rated by its probability of occurrence: Highly Unlikely, Unlikely, Possible, Likely, or Highly Likely using Table 8. Similarly, the impact of the risk, if realized, is rated as Low, Minor, Moderate, Significant, or Severe using Table 9. Evaluation of the risks will be based on data collected from subject matter experts. Using the probability of occurrence and the impact, an overall risk level will be identified. Definition of the rating system and the associated color code assigned for the different ratings are shown in the risk summary matrix (Figure 2) and in Table 10.

Table 8: Likelihood Calculation

Likelihood

Level	Likelihood	Probability of Occurrence
1	Not Likely	~10%
2	Low Likelihood	~30%
3	Likely	~50%
4	Highly Likely	~70%
5	Near Certainty	~90%

Table 9: Consequence Calculation

Level	Technical Performance	Schedule	Cost
1	Minimal or No Consequence to Technical Performance	Minimal or No Impact	Minimal or No Impact
2	Minor reduction in technical performance or supportability, can be tolerated with little or no impact on program	Able to meet key dates Slip < * Weeks	Budget increase or unit production cost increases < ** (1% of Budget)
3	Moderate reduction in technical performance or supportability with limited impact on program objectives	Minor schedule slip. Able to meet key milestones with no schedule float Slip < * Week(s) Sub-system slip > * week(s) plus available float	Budget increase or unit production cost increase < ** (5% of Budget)
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success	Program critical path affected Slip < * Week(s)	Budget increase or unit production cost increase < ** (10% of Budget)
5	Severe degradation in technical performance; Cannot meet KPP or key technical/supportability threshold; will jeopardize program success	Cannot meet key program milestones Slip > * Week(s)	Exceeds APB threshold > ** (10% of Budget)

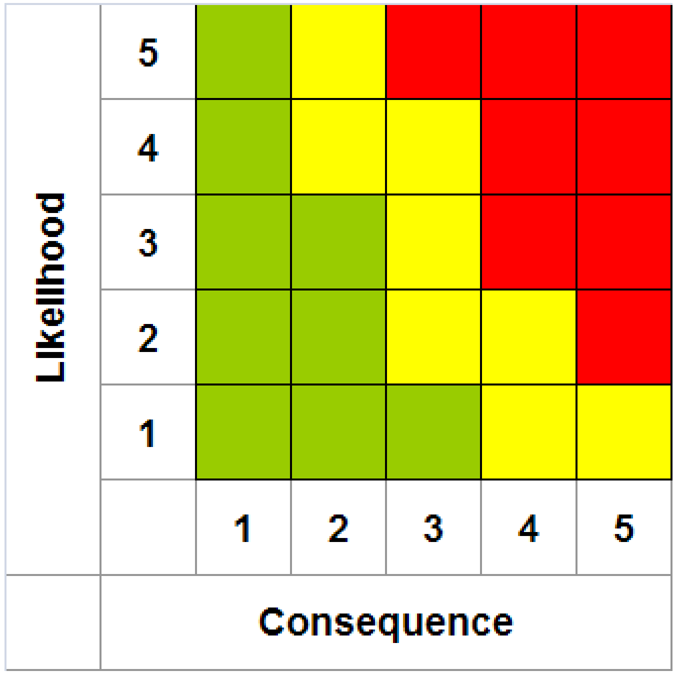


Figure 2: Risk Summary Matrix

Once the risks are characterized, priorities are assigned based on their relative probability and impact ratings to facilitate management and handling of these risks. The green boxes in Figure 2 identify the low priority level risks, yellow boxes indicate medium level risks while the red boxes identify the risks that warrant higher priority for handling and management. The impact of the risk level is outlined in Table 10 below.

Table 10: Risk Impact & Color Code

High	Likely to cause significant serious disruption of schedule, increase in cost, or degradation of performance even with special contractor emphasis and close government monitoring.
Moderate	Can potentially cause some disruption of schedule, increase in cost, or degradation of performance. However, special contractor emphasis and close government monitoring will probably be able to overcome difficulties.
Low	Has little potential to cause disruption of schedule, increase in cost, or performance. Normal contractor effort and normal government monitoring will probably be able to overcome difficulties.

Risk mitigation actions will be proposed for each of the identified risks and provided to the stakeholders for evaluation. Priorities for mitigation will be based on impact level with the highest impact items on the top of the list down to the lower risk items.

9.2.2 Opportunity Assessment

Opportunities on the program will be evaluated in similar fashion to risks. The probability and benefit rating are similar to the risk assessment approach and are shown in Figure 3 below. As with the risk matrix, opportunities will be ranked in terms of impact from Low to Severe and in terms of probability from Highly Unlikely to Highly Likely. As with risk, those items with the highest opportunity will be pursued since they provide the maximum benefit to the program.

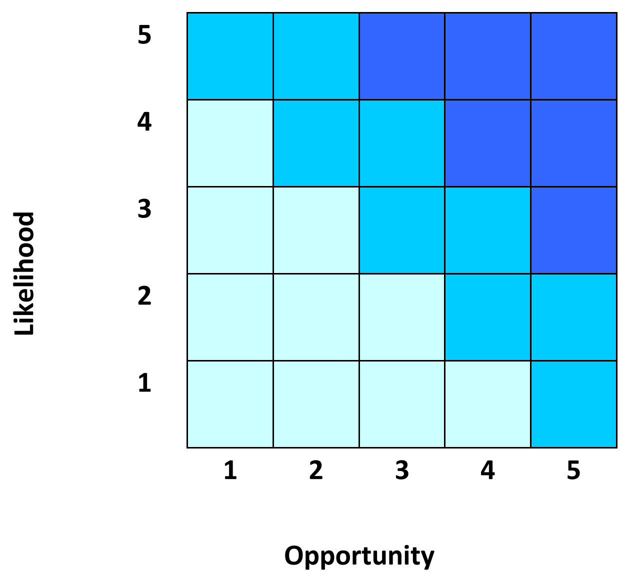


Figure 3: Opportunity Matrix

9.3 Procurement Plan

The Procurement Plan is the portion of the Acquisition Strategy related to contracting actions. The first priority in developing a procurement plan is to conduct market research. Initially we conducted research to determine types of commercially available systems in existence. This research may also be used to determine the state of the industrial base that would be contracted for these systems, a general understanding of the type and number of companies, as well as development and manufacturing capabilities will help in developing our contracting strategy.

With a good understanding of the market place as well as the program requirements, it is possible to move forward with a contracting strategy. The technology requirements associated with the emergency shelter seem relatively mature. There will however be developmental work as well as prototypes that will be required during our development process. It is also likely that there will be multiple types of

shelters which will require integration during the development stages. Given the unknowns associated with the developmental elements of this program. The team has decided to move forward by awarding multiple Cost Plus Fixed Fee Contracts. These contracts will be written such that a down select may occur at the end of the developmental process prior to any production decision. From this point, the team will award Firm Fixed Incentive Contracts for build of the initial production quantities during Low Rate Initial Production. The incentive portion of the contract is in place to aid in ramping up of the production quantity capability prior to transition to Full rate production. Once we reach and are approved for full rate production, the contracts will shift to Firm Fixed Price. This contracting strategy exists to share the burden of risk associated with the development of our emergency structures between the contractors and the government. As the system matures, the manufacturing risks are shifted to the vendor while the government manages other risks associated with the system.

9.4 Program Planning, Control, and Administration

The following contains the Capstone team's approach to project control for cost and schedule. A baseline project schedule will be developed and maintained in Microsoft Project and used for controlling and monitoring schedule performance.

Schedule Tracking – The Program Manager/Team Leader and Scheduler will work with task owners to capture weekly physical progress and any issues related to their respective work packages. The progress will be captured in Microsoft Project and communicated via Saki messaging or verbally in weekly team meetings.

Schedule Monitoring and Resolution – Identified schedule risk items will be assessed by the Program Manager/Team Leader and Scheduler for total program impacts and actions will be developed by the team for critical items (actions may include redirection of resources, rescheduling of tasks, etc..), and action owners will report task status until complete.

Cost Tracking - Actual expenditures will be documented by the Finance Officer and compared against the total budget of $10,000 (If funding is secured). All expenditures must be authorized by the majority of the team (via poll or informal team meeting vote) and will be discussed in weekly team meetings. Potential expenses for the project may include but is not limited to the purchasing of materials to construct prototype, cost to test, cost of travel for selected team members, etc.

9.5 Configuration Management

Configuration management involves identifying the configuration of a system at given points in time, controlling changes to the configuration in systematic manners, and maintaining the integrity and traceability of the configuration throughout the lifecycle of the system. The librarian for this system will also be the configuration manager and responsible for keeping a complete traceable trail of decisions, designs, design modifications, and documented changes. This includes gathering and cataloguing all reference material provided by Cohort 311-101O, from herein is referred to as the team. The configuration manager will also be responsible for version control of all project documentation including the final report and briefing packages. Within the project configuration management repository, each

configured item will be individually checked into the team's repository. Version control will be accomplished using a numerical revision number in combination with the date and the author(s). The revision number ensures that editorial consistency is maintained. The Sakai group file exchange will be utilized to exchange and store versioned files. The configuration manager will be responsible for archiving and keeping a backup copy of all files posted to the Sakai group file exchange.

The use of configuration management tools will enable the team to apply industry standards to all documentation. It will also enable team to manage the quality and development of products as the system is developed for the final proposal. The process and procedures utilized in providing guidance are the American National Standards Institute/Electronic Industries Alliance-649 [1998], Military Handbook-61A (SE) [2007], and the Defense Acquisition Guidebook [2006] Chapter 4, section 4.2.3.6.

Documentation of any systems engineering project must be maintained throughout the development and operational life of a system. This ensures the integrity of the information and process, providing the stakeholder or customer a reliable product and documentation trail for audit, revision, and requirements.

The Configuration Control Board (CCB) which comprises of the team members. The CCB is responsible for evaluating and making the decision as to when and if any changes are to be made in regards to work products or schedule events. The CCB reviews and evaluates the proposed changes for impact. Subsequently to the evaluation, the CCB can approve, reject or request additional information in support of making the ultimate assessment.

10 Technical Approach

10.1 Systems Engineering Model

The HASS shall utilize the Rapid Prototyping Systems Engineering model to help achieve the desired capability. The Rapid Prototyping diagram is shown below in Figure 4 is as depicted in its original form briefed at the 9th Annual NDIA Systems Engineering Conference in 2006. The "V" represents the sequence of steps to quickly prototype a material solution with consideration taken to systems engineering. It describes the activities and results that will be produced during product development. The left side of the "V" represents definition and decomposition. The right side of the "V" represents integration of parts and qualification of the system.

The Rapid Prototyping Systems Engineering "V" model depiction below is requirements-driven, and starts with identification of user requirements. When these are understood and agreed-to, they are then placed under project control, and through decomposition the system concepts and system specification are developed. The decomposition and definition process is repeated over and over until; ultimately, piece parts are identified. Agreement is reached at each level, and the decisions are placed under project configuration management before proceeding to the next level. When the lowest level is defined, we move upward through the integration and verification process on the right leg of the V to

ultimately arrive at the demonstrated prototype. At each level there is a direct correlation between activities on the left and right sides of the V – the rationale for the shape.

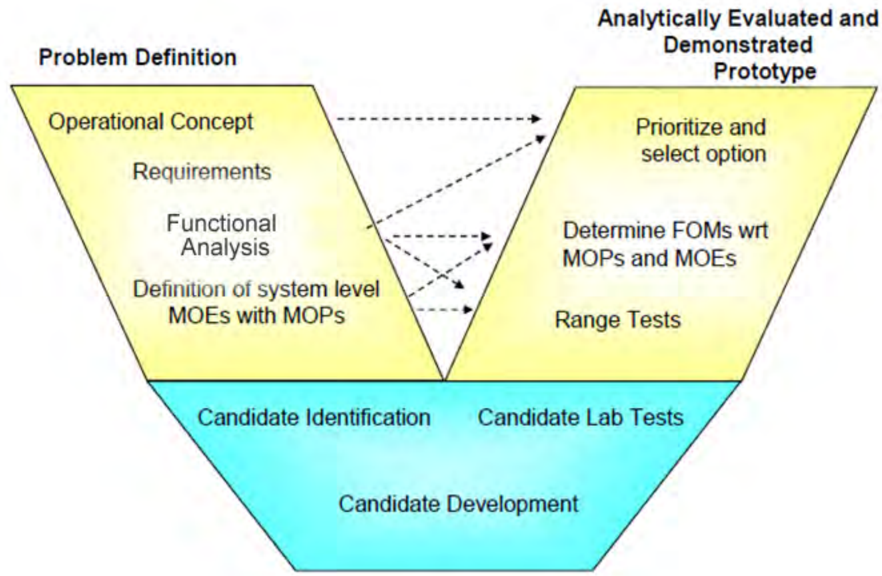


Figure 4: Rapid Prototyping Systems Engineering Model

The V-Model provides guidance for the planning and realization of projects. The following objectives are intended to be achieved by the HASS system:

Minimization of Project Risks: The V-Model improves project transparency and project control by specifying standardized approaches and describing the corresponding results and responsible roles. It permits an early recognition of planning deviations and risks and improves process management, thus reducing the project risk.

Improvement and Guarantee of Quality: As a standardized process model, the V-Model ensures that the results to be provided are complete and have the desired quality (Reference “Systems Engineering Standards and Models Compared” By Sarah Sheard). Defined interim results can be checked at an early stage. Uniform product contents will improve readability, understandability and verifiability.

Reduction of Total Cost over Rapid Prototyping effort: The effort for the development and rapid prototyping can be calculated, estimated and controlled in a transparent manner by applying a standardized process model. The results obtained are uniform and easily retraced. This reduces the acquirer’s dependency on the supplier and the effort for subsequent activities and projects.

Improvement of Communication between all Stakeholders: The standardized and uniform description of all relevant elements and terms is the basis for the mutual understanding between all stakeholders. Thus, the frictional loss between user, acquirer, supplier and developer is reduced.

10.2 Conceptual Design

10.2.1 Objectives

The HASS design and development process shall begin with a Conceptual Design phase to predetermine the function, form, cost and development schedule of the system. The starting point shall be the problem identification and associated MNS. Selection of a path forward for the configuration of the system in order to meet stakeholder requirements is a major focal point in the Conceptual Design phase. Additionally, this phase of the design effort shall evaluate a full spectrum of technologies and is a critical step in the implementation of the systems engineering process.

The following objectives shall be the focal point of the Conceptual Design phase:

- Identifying problems and translating them into a definition of the need for a system that will provide a solution
- Accomplishing advanced system planning in response to the identified need.
- Developing system operational requirements describing the functions that the system must perform in accomplishing its intended mission.
- Proposing a maintenance concept for the sustaining support of the system throughout its intended mission.
- Identifying and prioritizing technical performance measures and related criteria for design.
- Accomplishing a system level functional analysis and allocating requirements to the various subsystems and below as applicable.
- Performing system analyses and producing useful trade-off studies
- Developing a system specification
- Conducting a conceptual design review (SFR)

10.2.2 Operational View (OV-1)

Figure 5 below depicts the current preliminary operational view (OV-1) for the HASS based upon the MNS and FA.

10.2.3 Functional Analysis

A preliminary functional analysis based upon the MNS is available in Appendix D.

10.2.4 Concept of Operations

10.2.4.1 System Objectives

The primary objective of the HASS is to quickly provide basic shelter to disaster victims following a disaster. Over the course of the month following the disaster, the capabilities of the HASS are then increased to provide a more transitional shelter system which can sustain the disaster victims for an extended period of time; providing safe and effective lodging with the basic needs of living.

Figure 5: Operational View (OV-1

10.2.4.2 General Implementation Strategy

When a disaster occurs somewhere within the world, the US Government activates the military disaster relief organizations either at the request of the local government or in coordination with the local government. The HASS is moved from its storage location through airlift/air drop, sealift, or convoys to the disaster site or some intermediate distribution center where further transport awaits. The HASS is initially delivered and set up on-site by the untrained disaster victims themselves or the disaster relief personnel within the few days immediately following the disaster. The initial HASS is then inhabited by the displaced persons with their emergency supplies for a duration no longer than 30 days; after which the HASS's capabilities are increased through additional supply efforts to address all needs in the MNS.

The HASS's general implementation strategy can be graphically viewed in the OV-1 above (Figure 5).

10.2.4.3 Organizations and activities

Local Governments

Local governments are responsible for letting others know that aid is needed and would be welcome. They should also make known the type of aid (shelter, food, water, etc.) needed and some estimate on quantity required. They should provide all possible assistance in making a location close to the disaster site available as a central point for collection and dissemination of the aid received. The local government should provide for the security of the aid supplies before distribution to prevent pilferage by displaced persons or their citizens. They should also provide security and guide personnel to escort HASS shipment to its final set-up location. They are responsible for maintaining law and order of their citizens so that aid workers are safe.

US Government

The US Government should be receptive to the request for aid from the local governments. They should make arrangement to expeditiously deliver the requested aid to the site specified. They are responsible for the conduct of their citizens and to respect the customs and mores of the local population.

On -Land Distribution Center

The on-land distribution center, if used, must be provided to the US government for distribution of the HASS and other related supplies. The local government is responsible for aiding in this distribution to the maximum extent possible in order to expedite the process. This may entail providing such information as affected areas, population amounts, distribution routes, etc. This may also entail providing distribution and setup means such as trucks or available personnel. The US Government is responsible for the conduct of their personnel and to respect the customs and mores of the local population.

Transportation

The HASS shall be moved from its continental US storage location by whatever means (military or civilian; ground, air, rail, etc.) expeditiously and economically meets the requirements to the nearest port or airfield of embarkation. The ship or aircraft will transport the HASS to the disaster site or land based distribution center, as appropriate. If off-loaded at the land-based distribution center, further transportation from there will be required to the disaster site via ground transportation or helicopter. Regardless of the mode of transportation, the HASS will be delivered to as close to the set-up site as possible.

Set-up

The HASS is designed to be easily set-up by untrained personnel using common tools and accessories. Site preparation is limited to having a relatively level clear space; preferable on solid soil.

10.2.4.4 Interactions among users and stakeholders & their individual responsibilities

Stakeholders

Stakeholders are responsible for procuring and delivering the HASS to the users' disaster site. The stakeholders will aid the users in any means possible to expedite the setup and utilization of the HASS system for all displaced users. The users are in charge of providing any additional inputs or supplies that may integrate into the HASS such as pressurized water, fuel, electricity, or general goods.

Users

The users are the displaced victims of the disaster. Their initial responsibility is to set-up the HASS upon receipt. They are also responsible for acquiring and replenishing their emergency supplies. While residing in the shelter, the user is responsible for maintaining the unit. When notified that a more permanent shelter is available, the users should avail themselves of this improved habitat.

10.2.4.5 Constraints affecting the systems

Constraints affecting the systems

- The HASS is not intended to become a permanent dwelling.
- The HASS is not intended to be re-used.
- The HASS is weight-limited.
- The HASS has a lifespan (expiration date).
- The HASS requires inputs such as water, power, provisions, or other items for personal use (linens, sanitary items, etc.) to meet operational requirements.
- The HASS is not intended to house more than five adults.

10.2.4.6 Processes for system initiation & development

The designers intend for the system to be safe, easy to use, cost-effective and useful in virtually any kind of disaster response environment. The system can be manufactured by any entity which has the ability to obtain and work with the materials specified. While initial design and manufacture will take place in the United States, it is likely that additional development and enhancement of the product will take place outside the U.S.

Initial product development and modification will be accomplished following operational test and evaluation. It is envisioned that further feedback and development will occur once the product has been deployed and used in an actual disaster scenario. The information obtained following real-world system employment will be vital to product development.

10.2.4.7 Maintenance, Repair, and Disposal

The maintenance actions required by the HASS will be minimal and will require no specialized training or tools to complete. Maintenance actions will primarily consist of preventative maintenance actions such as cleaning, removing snow loads, securing the structure for high winds or dust, and other such actions associated with operating the HASS in external elements. All maintenance actions will be completed by the users.

When repair actions are required by the HASS, they will be minimal and will require no specialized training or tools to complete. The goal is to provide the most durable/reliable shelter system possible, as to achieve an operational availability of 90%. The HASS will also limit substantial repair actions through its design, which will ensure a 50% probability of completing 6 months of operation without a major component failure. Major components include coverings, liners, fabrics, structural components, or any other component of the structure which is associated with providing the primary needs of the HASS as defined in the MNS. All repair actions will be performed by the users or trained personnel when available.

The responsibility of disposing of the HASS falls on the users or the users' local government. From the stakeholder's perspective, the HASS is an expendable system. The HASS may be disposed of in any municipal waste facility since it is non-toxic and made of normal construction materials.

10.2.4.8 HASS Operational Activity Hierarchy Diagram (OV-5)

The diagram in Figure 6 depicts the HASS' major operational activities in chronological order. In accordance with the MNS, the three main activities the HASS must perform are to Operate, Protect, and Serve. The operate activity primarily consists of activities associated with the construction and utilization of the shelter. The protect activity primarily consists of activities associated with protecting the occupants; providing them with a livable and safe atmosphere. The serve activity primarily consists of activities associated with HASS components. These HASS components are not part of the physical structure, but are components which integrate into the HASS to provide the users with capabilities which are necessary to their survival and health.

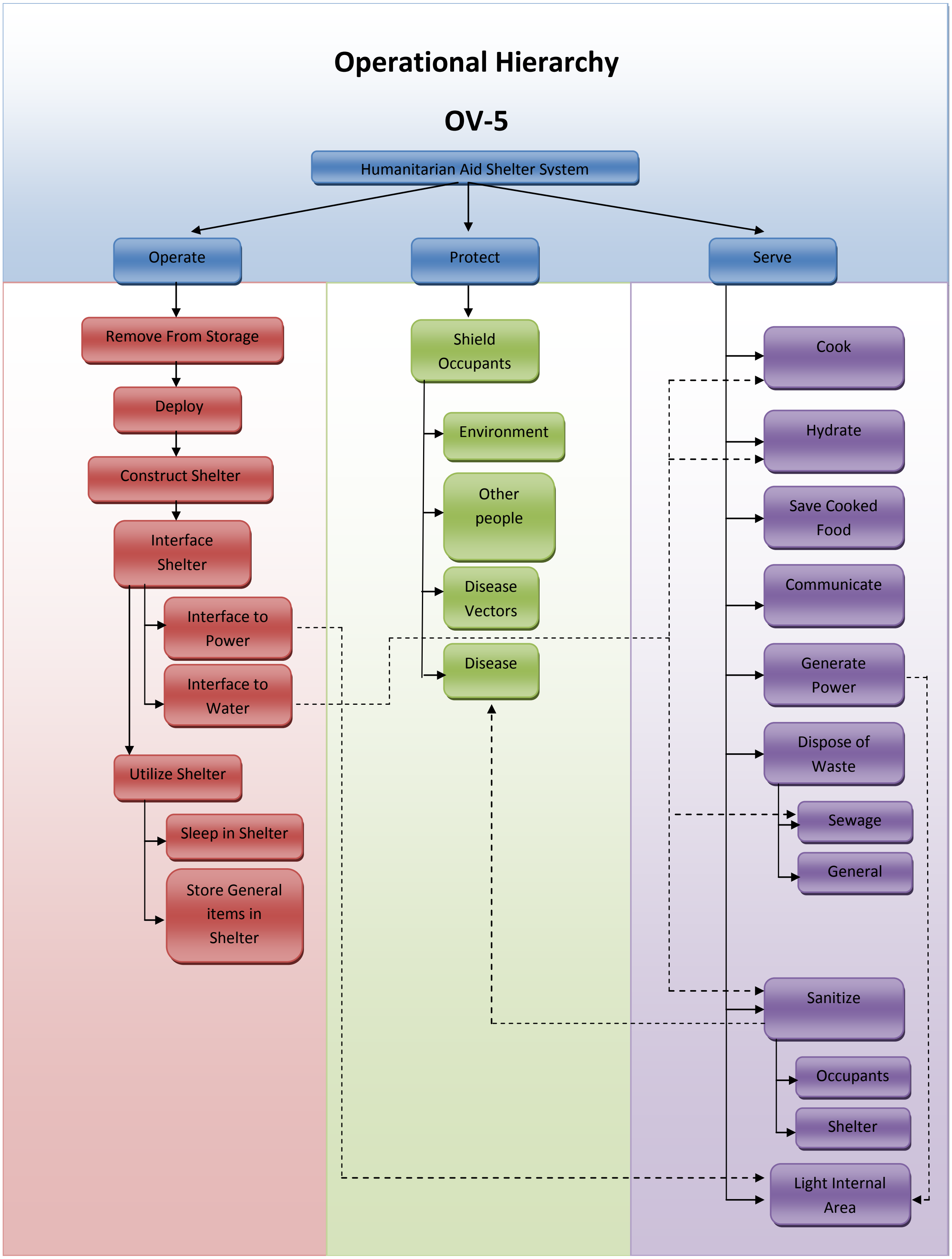


Figure 6: HASS Operational Activity Hierarchy Diagram

10.2.5 System Operational Requirements

A set of operational requirements shall be generated once the need and technical approach have been defined. Operational Views using DODAF 2.0 shall address operational requirements in the areas listed in Table 11 below.

Table 11: Operational View Areas

Operational Requirements factors	***Definition***
Mission definition	Identification of prime mission of the system
Performance and physical parameters	Definition of the operating characteristics or functions of the system
Operational deployment or distribution	Identification of the quantity of equipment; software, personnel, facilities and expected geographical location
Operational Life-cycle	Anticipated time that the system will be in operational use
Utilization Requirements	Anticipated usage of the system and its elements
Effectiveness Factors	System requirements specified as figure of merit (Availability, Readiness Rate, Mean Down Time
Environment	Definition of the environment in which the system is expected to operate (temp, humidity etc)

10.2.6 Technical Performance Measures and Functional Analysis

The HASS shall generate Technical Performance Measures (TPM) to describe system performance requirements. TPMs are measures of the attributes and characteristics which are inherent to the design of the shelter. Factors such as reliability, maintainability, and operational availability are some examples of TPMs that will be taken into consideration during the conceptual design phase of the HASS. The objective of generating TPMs is to influence the system design process to incorporate the right attributes/characteristics to produce a system entity that will ultimately meet stakeholder requirements in an effective and efficient manner.

A functional analysis shall be generated in the conceptual design phase to describe the functional behavior of the HASS and to serve as a basis for the identification of the resources necessary for the system to accomplish its mission. A function will be a specific or discrete action or actions that are necessary to achieve a given objective. The functional analysis is an iterative process of translating system requirements into detail design criteria. It includes breaking requirements at the system level down to the subsystems for the HASS.

Functional Flow Block Diagrams (FFBD), IDEF modeling methods, or some other form of function organization shall be used to decompose functions of the HASS. The team shall prepare such diagrams

to facilitate the break-down of top level functions into second level functions and third level functions. The functions shall be broken down to a level necessary to adequately describe functional interface relationships and identify the resources needed for functional implementation.

10.2.7 System Specification

A major objective during the Conceptual Design phase is the generation of the System Specification. This specification defines the top level technical requirements which provide the basis for system design. The System Specification shall be prepared and the conclusion of the conceptual design phase. This specification will be utilized as a baseline for all HASS lower level subsystems.

10.2.8 Conceptual Design Review

The HASS team shall conduct a Conceptual Design Review, preferably a System Functional Review at the conclusion of the Conceptual Design phase. The design review shall ensure that the effort and design can proceed into the next phase. This evaluation is conducted to ensure that the design is correct at that point before proceeding with the next stage. Design information for the HASS shall be reviewed for compliance with the system equipment requirements as defined by the system specification. If the requirements are satisfied, the design is approved to proceed to the next stage.

10.3 Preliminary Design

10.3.1 Objectives

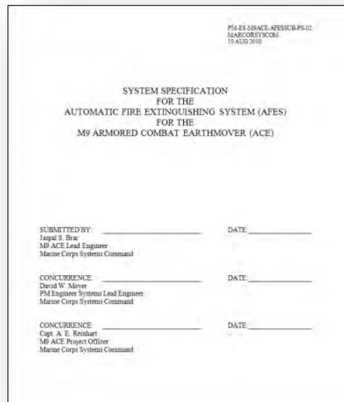
The HASS shall leverage on activities performed in the Conceptual Design phase to address definition and development of requirements for subsystems. The focal point of this phase will be demonstrate that the selected system concept will conform to performance and design specification and that it can be produced within cost and schedule constraints. The following steps shall be executed during the Preliminary Design phase of the HASS:

- Developing design requirements from system level requirements for subsystems
- Preparing development, product, process and material specifications as necessary for subsystems
- Accomplishing functional analysis and allocation at and below the subsystem level
- Establishing detail design requirements and developing plans for their allocation to engineering specialties
- Identifying and utilizing appropriate engineering design tools and technologies
- Conducting trade-off studies
- Conducting design reviews

10.3.2 Subsystem Design Requirements

The HASS shall utilize a hierarchy of subsystem specifications as necessary to describe products, processes and material specifications. The subsystem specifications shall be derived from system design requirements which in turn are traceable to operational requirements and the prioritization of TPMs. The generation of Subsystems Specifications is currently under review by the SE IPT and thus is a

tentative effort. This will be accomplished through the use of a functional analysis and allocation to describe the major elements of the system. A sample of a Subsystem Specification is included in Figure 7.



PM-ES-M9ACE-AFESSUB-PS-02
MARCORSYSCOM
19 AUG 2010

SYSTEM SPECIFICATION
FOR THE
AUTOMATIC FIRE EXTINGUISHING SYSTEM (AFES)
FOR THE
M9 ARMORED COMBAT EARTHMOVER (ACE)

SUBMITTED BY: ______________________ DATE: ____________
Jaspal S. Brar
M9 ACE Lead Engineer
Marine Corps Systems Command

CONCURRENCE: ______________________ DATE: ____________
David W. Moyer
PM Engineer Systems Lead Engineer
Marine Corps Systems Command

CONCURRENCE: ______________________ DATE: ____________
Capt. A. E. Reinhart
M9 ACE Project Officer
Marine Corps Systems Command

Figure 7: Subsystem Specification Sample

10.3.3 Functional Analysis and Allocation

The HASS shall decompose functions down to an appropriate level to determine if a new or an existing design is required and/ or to a level at which the design team wishes to establish some specific design to requirements as an input. An FFBD shall be used to illustrate a breakdown of functions into sub functions and ultimately describe major subsystems. The functional analysis will describe the "what's" of the HASS subsystems.

The next step will be to determine the "hows" of the subsystems and this will be accomplished through the use of FFBDs. This shall be evaluated to determine what mechanisms and resources are required for accomplishing the function, i.e., equipment, software, people, facilities or various combinations thereof.

10.4 Detail Design

10.4.1 Objectives

The Humanitarian Aid Shelter System shall accomplish a number of overarching objectives during the detail design phase to describe the lowest level components of the system. This description includes subsystems, units, assemblies, lower level components, software modules, and people that make up the system. The design team shall tailor as necessary to meet schedule and budget constraints. The design team shall prepare specifications and design data for all system components and acquire and integrate the selected components into a final system configuration. The overall objectives of the detail design shall be the following:

1) Develop design requirements for lower-level components of the HASS
2) Integrate system elements and activities
3) Utilize design tools and aids
4) Prepare design data and documentation

5) Develop engineering and prototype models
6) Implement a design review, evaluation and feedback capability
7) Incorporate design changes as necessary

10.4.2 Design Requirements

The HASS shall refine requirements that define system components as necessary. Requirements shall be derived from the system specification and all lower specifications. The design team shall refine these requirements through synthesis, analysis, and evaluation during the detail design phase.

10.4.3 System Hardware

From the functional analysis performed in Conceptual Design and Preliminary Design phase, the HASS team shall identify various elements of the system and the need for hardware and equipment. The following options shall be considered when selecting and identifying system hardware:

1) Select Commercial-Off-The-Shelf (COTS) component or equivalent
2) Modify existing commercially available off-the-shelf items
3) Design and develop a new and unique item or component

10.4.4 Design Tools and Aids

The HASS successful integration is dependent on available design tools and aids to help the design team accomplish its objectives in a timely manner. The application of Computer Aided Design (CAD) tools shall enable the team to evaluate various options during the detail design phase. The tools shall be used to visualize the system prior to realization and potentially validate system requirements. Validation shall be accomplished through simulations prior to the introduction of hardware. The design shall be integrated using applicable technologies in the virtual space prior to procurement of hardware and equipment.

10.5 Integration

The INCOSE SE Handbook v3.1 states that "The purpose of the Integration Process is to realize the system-of-interest by progressively combining system elements in accordance with the architectural design requirements and the integration strategy." Integration is a critical focus of the design process for a new system. If a new system is unable to interface with legacy systems, other mission components, or if the individual components of the system cannot be linked together, the system will not perform its intended mission. In the case of an HA/DR shelter, there are a number of ways that the system must be integrated. Internally to the HASS concept, the individual components of the system must be capable of linking together be it through a physical connection or a data connection. Externally, the HASS must interface with any other relevant HA/DR components such as water purification systems, transportation modes, and even with the users. Other potential integration challenges include test equipment, maintenance, and production equipment. These challenges will arise at various levels of product development and fielding but must be addressed from the start.

There are a number of tools in place for the design and management of system interfaces. Some of the tools include:

- Interface Management Plan
- Memorandum of Understanding
- Single Point of Contact
- Interface Control Working Group (ICWG)
- Interface Control Document (ICD)
- Interface Change Notice
- Configuration Control Board

The overall goal of the above tools is to manage the interface once it is defined and finalized. For example, a system interfacing with a piece of electrical equipment must use a specific type of connector. This would be defined in an ICD. If the electrical component were to be changed (through the CCB) an Interface Change Notice would have to be produced. If approved by the CCB, the interfacing system must then be changed to the new connector. For the purpose of the HASS, the internal interfaces would be managed by the vendor of the shelter. However, if it is decided that the shelter must interface with Commercial off the Shelf (COTS) components or systems in development, the interfaces of those components must be well defined and designed to. A COTS interface will likely require that the HASS conform to the already existing interface. Any components in development may still be open to configuration changes. In this scenario, configuration management is a critical activity in keeping ICDs up to date and accurate for both systems.

10.6 Verification

In its simplest form, the verification process serves to ensure that the system has been built right. This includes mapping specific design features to the original design and mapping functions to the original functional architecture. The verification process occurs throughout the SE process and serves as a "sanity check" to ensure that we are still building the system right.

In the basic SE Vee, Verification and Validation compose the right hand side of the Vee. Figure 8 is the Integrated Defense AT&L Life Cycle Management Chart's Pre Concept/Materiel Solution Analysis Vee. Verification begins with the component level and then matures through the subsystem and system levels. The figure shows the input and outputs to the activity as well as the traditional top down, bottom up approach. At the start of the verification process, enabling or critical components are compared back to the desired capabilities of the system. In the next phase of the verification, the system concept is verified against the required functional capabilities of the architecture/design. Finally, the entire concept's performance is verified against the stated requirements. This process is iterative and may be applied many times over before the validation process occurs. Once it has been verified that the system has been built right, the validation activity serves to ensure that the right system has been built. There is direct traceability back to the design activities from the verification side of the process. This top down bottom up approach can be used throughout the lifecycle of the system and is considered during the Technology Development, Engineering and Manufacturing Development, Production and Deployment, and Operations and Support Phases. The chart can be found at https://ilc.dau.mil/.

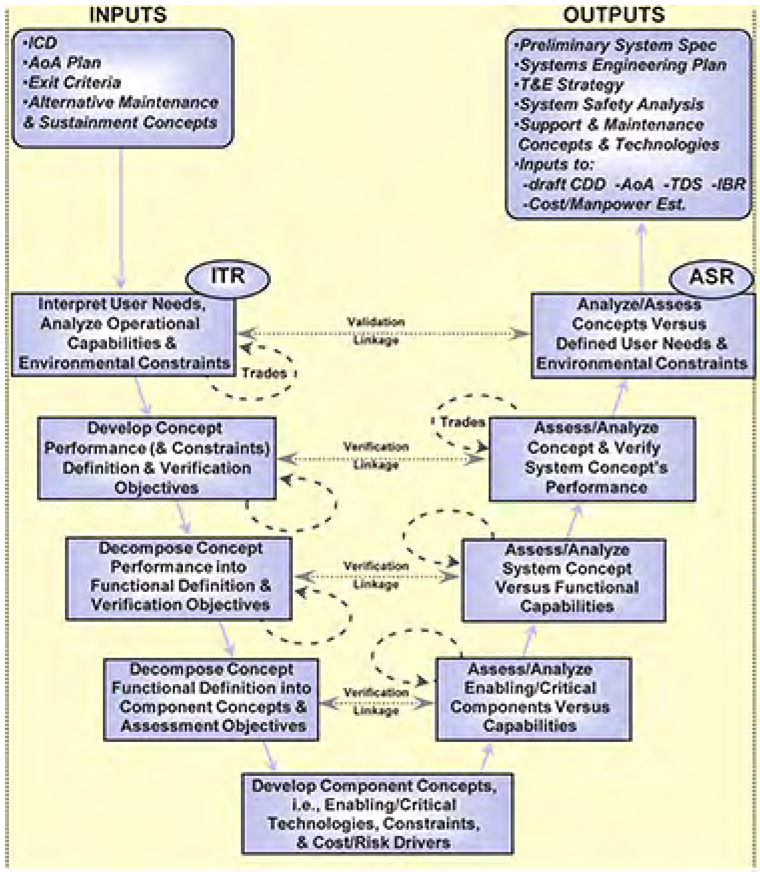


Figure 8: Pre Concept/Materiel Solution Analysis Phase Vee (https://ilc.dau.mil/)

10.7 Quality Assurance

For a system like the HASS, Quality Assurance will need to be included in several acquisition activities. Several QA standards are readily available, including the ISO 9000 family of standards for quality management as well as the ISO 10006:2003 guideline for quality management in projects. These two standards should guide the developer to generate a set of procedures to monitor processes to ensure they are effective such as: keeping adequate records; checking outputs for defects, with appropriate and corrective action where necessary; regularly reviewing individual processes and the quality of the system itself for effectiveness; and the facilitation of continual improvement

11 Methods, Tools, and Techniques

The project will employ a number of modeling, simulation and project management tools. All applicable tools expected to be utilized during this effort are readily available to the team and are listed below:

- Sakai Resources
- Dudley Knox Library
- NPS Citrix Gateway
    - ExtendSIM

  - Minitab
  - CORE
- Microsoft Office Suite (Word, Excel, PowerPoint, Project)
- Solidworks CAD software or a comparable software suite

Alternatives will be generated, modeled and evaluated using tools listed above. Simulation outputs and statistical data will be used to evaluate the overall effectiveness and performance of the selected alternatives.

11.1 Core

The Capstone Team will use Core to establish and maintain requirements, architecture and analysis products and ensure they remain mutually supportive over time. By using Core, the team intends to employ a rigorous approach to ensure that what we initially specify from the time of meeting with stakeholders is consistent with what we end up defining for the elaborated end state prototype shelter solution.

11.2 3D Model

11.2.1 Method

In order to develop a feasibly robust system that is easily explained to the user, a comprehensive 3D model will be generated. This 3D model will accurately depict every component of the system and how they integrate into the shelter as well as each other. This method of concept development allows for the rapid review and change of the entire concept design as well as the detailed design. It will also alert the SE team to any emergent dimensional properties which would negatively impact the functions of the system, e.g., when integrated with every component, the shelter's sleeping area is overcrowded. A limited amount of finite analysis may also be performed on critical structural components of the shelter; alerting the conceptual design team to any emergent structural inadequacies which may be in conflict with certain performance requirements.

A 3D model of this nature also aids in the prototype construction phase/deployment fabrication phase, as engineering design drawings are easily generated from the 3D concept model to aid in fabrication efforts.

Examples of 3D models utilizing both a hard shelter technology and a soft shelter technology can be seen in Figure 9 and Figure 10 below.

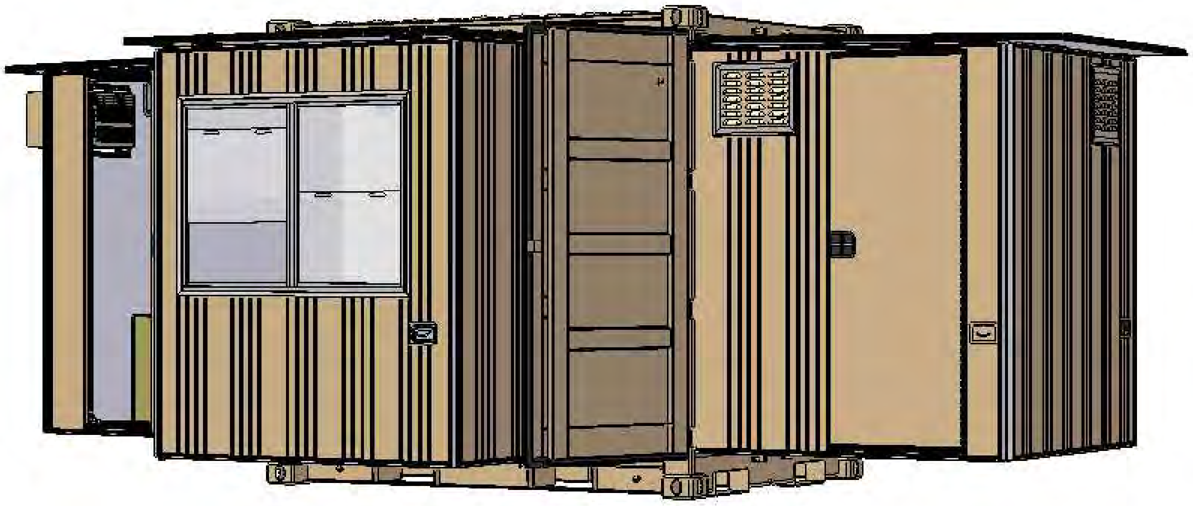


Figure 9: Expandable Hard Shelter Technology Model

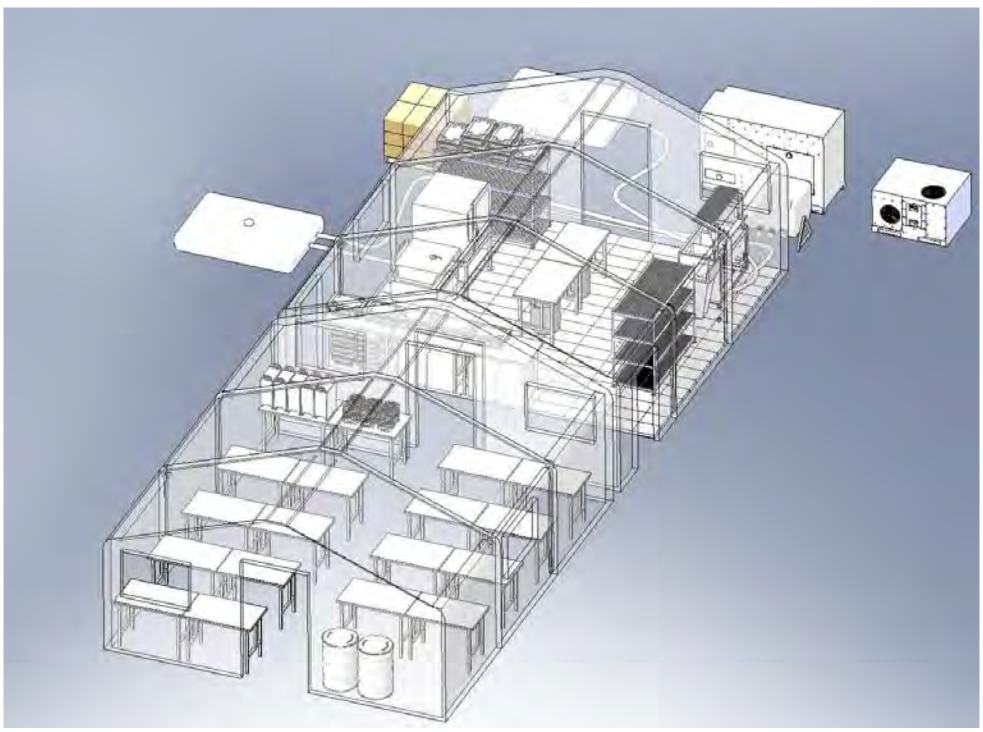


Figure 10: Soft Shelter Technology Model

11.2.2 Tools

The tools necessary to generate and manage such a 3D model include: a high powered PC, the internet, and the software SolidWorks™ or a comparable software suite. SolidWorks is the primary tool needed to generate such a 3D model. The PC and internet are merely stated since they run and support the software respectively.

Solidworks is an extremely powerful 3D engineering design software suite. Not only is SolidWorks capable of generating 3D models, it is capable of seamlessly integrating with many other engineering analysis/design tools such as: finite analysis, fluids analysis, and 3D printing capabilities for rapid prototyping models.

Finite analysis is used to simulate physical forces upon models; fluids analysis is used to simulate a fluid or gas' effects on a model; and 3D printing is used to rapidly print components in a 3D manner utilizing a printable plastic compound. In an example of how these analysis components of the software could benefit the shelter's concept design, finite analysis could be performed on the shelter's container to determine if it will survive transportation scenarios; fluids analysis could be performed on the shelter's exterior to determine if it would survive certain wind conditions; and a component could be 3D printed if it were too costly to purchase or fabricate but needed to be physically available for review.

11.2.3 Techniques

Techniques to developing a good/manageable 3D model include:

- Breaking components assemblies down and modeling them at the correct level. Components should only be broken down and modeled to a level which is necessary. Excessive sub-component modeling can drastically slow down the computer system and may inhibit some analysis tools.
- A model naming scheme should be implemented. All models need to be named in a manner which aids in their manageability. File names should include things such as: Component name, sub-component name (if a sub-component), and date. Models should also be kept in folders which are named in accordance with the assembly they are a part of. If a model does not integrate into a standalone assembly, then it should be kept in its own folder.
- Drawings should indicate the person who drew them, the date, component or assembly name, revision number, and any other relevant title.
- Assembly and Sub-Assembly drawings should include a BOM.

Appendix A – Tentative Work Breakdown Schedule

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1	Disaster Shelter Project	X	X	X	X	X	X	X	X
1.1	Project Management								X
1.1.1	Planning								X
1.1.1.1	Project Management Plan								X
1.1.1.1.1	Draft PMP Team Review								X
1.1.1.1.2	Draft PMP due								X
1.1.1.1.3	Final PMP Team Review								X
1.1.1.1.4	Final PMP Due								X
1.1.2	Scheduling							X	
1.1.2.1	IPR#1							X	
1.1.2.1.1	IPR1 Presentation Development							X	
1.1.2.1.2	IPR1 Team Review, Refinements, Dry Run							X	
1.1.2.1.3	IPR1 Presentation Delivery							X	
1.1.2.2	IPR#2							X	
1.1.2.2.1	IPR2 Presentation Development							X	
1.1.2.2.2	IPR2 Team Review, Refinements, Dry Run							X	
1.1.2.2.3	IPR2 Presentation Delivery							X	

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.1.2.3	CDD, Final Report and Presentation						X		
1.1.2.3.01	CDD Development						X		
1.1.2.3.02	CDD Team Initial Review						X		
1.1.2.3.03	CDD Final Team Review						X		
1.1.2.3.04	Final Report Development						X		
1.1.2.3.05	Final Report Team Initial Review						X		
1.1.2.3.06	Final Report Team Final Review						X		
1.1.2.3.07	Final Report & CDD Due						X		
1.1.2.3.08	Final Presentation Development						X		
1.1.2.3.09	Final Presentation Team Review, Refinements, Dry Run						X		
1.1.2.3.10	Final Presentation Delivery						X		
1.1.5	Quality Assurance								X
1.1.8	Configuration Management								X
1.1.8.1	Change Management								X
1.1.9	Risk Management								X
1.1.10	Procurement Management								X
1.1.11	Communications								X

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.1.11.1	Develop MOAs with other system owners								
1.2	Perform System Engineering								
1.2.1	Identify Project Technical Processes								
1.2.2	Develop Technical Plans								
1.2.2.1	System Engineering Management Plan								
1.2.2.1.1	Draft Concept Phase SEMP Development								
1.2.2.1.2	Draft Concept Phase SEMP Team Review								
1.2.2.1.3	Final Concept Phase SEMP Team Review								
1.2.2.1.4	Final Concept Phase SEMP Due								
1.2.2.1.5	Update SEMP for Preliminary Design Phase								
1.2.2.1.6	Update SEMP for Detailed Design Phase								
1.2.2.2	… Management Plan								
1.2.2.1.5	Update … Management Plan for Preliminary Design Phase								
1.2.2.1.6	Update … Management Plan for Detailed Design Phase								
1.2.3	Perform Conceptual Design Phase Efforts			X					
1.2.3.01	Perform Literature Review	X		X					

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.2.3.015	Identify Assumptions			X					
1.2.3.02	Identify Stakeholders	X		X					
1.2.3.03	Develop Stakeholder Engagement Materials			X					
1.2.3.04	Perform Stakeholder Needs Analysis	X		X					
1.2.3.05	Develop Statement of Need/Problem		X	X					
1.2.3.06	Develop System Operational Requirements (MOEs)			X					
1.2.3.07	Develop System Operation Concept			X					
1.2.3.08	Develop Operational Activity Model (OV-5)			X					
1.2.3.09	Prioritize Operational Requirements (AHP Pairwise Comparison)			X					
1.2.3.10	Develop System Maintenance/Logistics Concept			X					
1.2.3.11	Perform Conceptual Design Phase Review			X					
1.2.4	Perform Preliminary Design Phase Efforts				X				
1.2.4.01	Perform Functional Analysis				X				
1.2.4.1.01	Identify Top Level System Functions				X				

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.2.4.1.02	Develop System Functional Description (Hierarchical SV-4) <should trace from OV-5>				X				
1.2.4.1.03	Develop Operation Activity to System Function Traceability Matrix ((SV-5a and SV-5b))				X				
1.2.4.1.04	Develop System Input, Output and External Interface Requirements				X				
1.2.4.1.05	Develop System Requirements to System Functions Traceability Matrix				X				
1.2.4.1.06	Develop System Interface Description (SV-1)				X				
1.2.4.1.07	Develop Technical Metrics, MOPs, and KPPs				X				
1.2.4.1.08	Develop Quality Functional Deployment (QFD) 1 (Measures of Effectiveness vs. Key Performance Parameters)				X				
1.2.4.1.09	Develop QFD2 (Key Performance Parameters vs. System Functions)				X				
1.2.4.1.10	Develop Function and Form/Component Mapping				X				
1.2.4.1.11	Develop QFD3 (Functions vs. Form/Components)				X				

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.2.4.2	Identify Preliminary Design Alternative				X				
1.2.4.2.1	Develop System Design Alternative Morphology				X				
1.2.4.2.2	Perform Down Select Analysis				X				
1.2.4.2.3	Perform Design Alternative Cost per KPP Analysis				X				
1.2.4.2.4	Perform Cost as an Independent Variable Analysis				X				
1.2.4.2.5	Perform System Lifecycle Cost Analysis				X				
1.2.4.2.6	Select Preliminary Design Alternative				X				
1.2.5	Perform Detail Design Phase Efforts					X			
1.2.5.1	Develop detail design of functional system (equipment and physical components)					X			
1.2.5.2	Perform Physical Analysis					X			
1.2.5.3	Develop HWCI Documentation (Procurement Specifications)					X			
1.2.5.4	Perform Logistics Supportability Analysis					X			
1.2.5.5	Develop Interface Control Documents					X			

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.2.5.6	Perform Critical Design Review					X			
1.2.5.7	Develop System Prototype					X			
1.2.5.7.1	Construct/Assemble Components					X			
1.2.5.7.2	Develop Interfaces					X			
1.2.6	Integrate Hardware Components					X			
1.2.7	Prepare for and Conduct Testing					X			
1.2.7.1	Develop Test Plan					X			
1.2.7.2	Develop Test Procedures					X			
1.2.7.3	Perform Component Testing					X			
1.2.7.4	Perform Integration Testing					X			
1.2.7.5	Perform System Level Testing					X			
1.2.7.6	Perform Interface Testing					X			
1.2.7.7	Perform Interoperability Testing					X			
1.2.7.8	Perform Deployment Testing					X			
1.3	Perform User Acceptance Testing					X			
1.4	Perform Physical Configuration Audit								
1.5	Develop Packaging								

WBS	WBS Description	1. Conduct a review of the history and literature of recent HA/DR operations with a particular attention to ones supported by the USN. Identify in that review the characteristics of typical HA/DR operations, and the particular shelter requirements generated by several of the historical disasters. From the review, generate a potential list of stakeholders and preliminary requirements.	2. Following the process in Blanchard and Fabrycky (Figure 2.3), or another one approved by your advisor, develop a definition of need	3. Develop a Conception Design	4. Upon approval of the conceptual design, complete a preliminary design.	5. Upon approval of the preliminary design, conduct all activities necessary to complete detailed design and development, culminating in a physical system prototype test and evaluation.	6. Prepare a well written and fully documented capstone report that describes your process, findings, and recommendations. Concurrently, prepare and deliver a 90 minute briefing summarizing your results.	7. Prepare and present in-progress reviews at the end of winter and spring quarters.	8. Comply with the administrative requirements your advisors impose, such as activity logs, project plans, PMPs, blogging, etc.
1.6	Develop Training Documentation								
1.7	Develop Logistics Support Documentation								
1.8	Perform Lifecycle Maintenance and Support								

Appendix B – Preliminary Mission Need Statement

NAVAL POSTGRADUATE SCHOOL

SE311-101O CAPSTONE PROJECT

10 FEBRUARY 2011

MISSION NEED STATEMENT

FOR THE

HUMANITARIAN ASSISTANCE SHELTER SYSTEM

SUBMITTED BY: ______________________________ DATE:___________________

Cohort 311-101O

Naval Postgraduate School

CONCURRENCE:______________________________ DATE:___________________

Brigitte Kwinn

Technical Advisor

Naval Postgraduate School

APPROVAL:______________________________ DATE:___________________

Dr. David H. Olwell

Capstone Project Director

Naval Postgraduate School

Record of Changes:

Date	Revision	Reason for Change	Entered by:
05 FEB 11	1	Initial Submission	J. Brar

Table of Contents

MISSION NEED STATEMENT

FOR THE

HUMANITARIAN ASSISTANCE SHELTER SYSTEM

Potential ACAT I through III

DATE: Jan 29, 2011

I CAPABILITY STATEMENT OF NEED

Mission Capability Gap. This Mission Need Statement (MNS) for the Humanitarian Assistance Shelter (HASS) supports the Naval Post Graduate School Capstone Project Guidance for 311-101O dated Jan 14, 2011. A capability gap exists in humanitarian shelters as there is not a prepackaged system that can be stored and then delivered to disaster victims easily and quickly when necessary. Currently, the U.S Government does not have a shelter system in place specifically designed to support Humanitarian Assistance (HA) and Disaster Relief (DR) operations. In order to support the future U.S Government humanitarian mission, shelter options and alternative shall provide a reliable, deployable, survivable and maintainable system to the user.

II PRIMARY CAPABILITY NEEDS

2.1 **Operating Environment Needs.** The environment that the Humanitarian Assistance Shelter shall see consists of worldwide natural disasters. The shelter solution shall be capable of operations and storage in environmental conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes. Capabilities of the shelter solution shall not be degraded when exposed to all types of climatic and weather conditions in accordance with MIL-HDBK-310 and MIL-STD-810.

2.2 **Transportability Needs.** The shelter solution shall be able to be transported on all modes of transportation including air, rail, ship and ground transport. Additionally, the HASS shall be transportable utilizing palletized packaging and standard shipping containers.

2.3 **Operational Deployment and Distribution.** The HASS shall be deployable from standard platforms which include land, sea and air systems within 3 days (Objective) and 30 days (Threshold). The total shelter shall be in one package which contains smaller packages broken down into parcels of weights suitable for transport by two people.

2.4 **Water Distribution.** The Shelter shall be able to process and store water for consumption, personal hygiene and food preparation. Shelter shall distribute water for human consumption and human waste in accordance within safe threshold limits as defined by Environmental Protection Agency (EPA) standards. Delivery of water for personal hygienic usage and food preparation shall meet regulatory requirements as defined by EPA health regulations.

2.5 **System Safety.** Components of the HASS shall protect occupants and be designed to minimize exposure of the users, maintenance and handling personnel to safety hazards during its use, storage, and transport. Components of the HASS shall include warning labels/indicators to warn of hazards. The HASS components shall be located, routed, and/or shielded to prevent injury to users in case of a fire hazard.

III SECONDARY CAPABILITY NEEDS

3.1 **Power Generation.** HASS shall provide power and interface with an external power source (Objective). The HASS shall interface with an external power source (Threshold).

3.2 **Human Engineering.** The HASS shall be operable and maintainable by the full range of personnel (5th percentile female through 95th percentile male) in accordance with MIL-STD-1472. The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and perform all required tasks. Components of the HASS shall be designed for ease of operations. Controls or displays shall be easy to locate, with visual indicators and messages easy to read in all light conditions.

3.3 **Materials.** The HASS shall contain no radioactive material and shall be free of cadmium plating and asbestos in accordance with SD-14. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs.

3.4 **Physical Parameters.** The HASS shelter shall provide covered shelter for six occupants. Each separable assembly of the HASS shall be designed for 2 person (Objective) and 4 person carry (threshold) in accordance with MIL-STD-1472. Packaged volume shall be in accordance with Transportability needs in Section 2.2

3.5 **Communications.** HASS shall incorporate provisions for one-way communication (Threshold) and two-way communication (Objective).

3.6 **Long Term Storage Needs.** The HASS shall be capable of storage for up to 5 years without degradation to performance and reduction in functional capacity. Applicable closures and containers shall be provisioned for long term storage.

3.7 **Reliability and Availability.** The HASS shall have a Mean Time Between Failure (MTBF) at the lower bound 90% confidence interval of 6 months (Objective) and 30 days (Threshold). The HASS shall attain an achieved availability (Ao) of 0.75 (T), 0.90 (O).

3.8 **Maintainability.** HASS shall be designed to require the minimum number of maintenance tasks (including calibration, adjustment, and inspection), skills and man-hours required to accomplish the required maintenance tasks, and tools and test equipment necessary to perform the required maintenance tasks. Any maintenance shall be performed by an untrained adult.

3.9 **Durability.** The HASS shall have a 50 percent probability of completing 4320 hours of operation without a major component durability failure. Major components include coverings, liners and fabrics and structural components.

3.10 **Food Preparation and storage.** The Human Assistance Shelter System shall equip occupant(s) with resources for food preparation. Occupant(s) shall have the capability to prepare food for human consumption inclusive of cooking with heat and/or electrical means. The HASS shall have provisions for food storage.

IV TERTIARY CAPABILITY NEEDS

4.1 **Construction and Setup Time.** Setup of the HASS shall be performed by untrained adult personnel within 2 hours (Objective) and 8 hours (Threshold). Timing shall be inclusive of packaging breakdown.

4.2 **Operational Lifecycle.** The HASS shall survive a shelf life of 5 years without degradation to performance or function. The HASS system shall survive an operational usage for duration of 6 months (Threshold) and 3 years objective. Operational duration is defined as any time outside of shelf time.

4.3 **Ventilation Provisions.** The HASS shall have provisions for forced ventilation (objective) and natural ventilation provisions (Threshold).

4.4 **Scalability.** The HASS shall be scalable and use open-systems architecture

4.5 **Sleeping Provisions.** The HASS shall accommodate 6 occupants and have adequate floor space for sleeping provisions.

Appendix C – Preliminary Risk List

This project is using the risk management strategy discussed in section 8.2, "Risk & Opportunity Management". This appendix lists some initial project risks, and assesses their likelihood and severity. Table 13-1 shows the initial project risks. Figure 13-2 is a risk matrix showing likelihood and severity for each risk.

Code	Risks	Consequences
A	Incorrect identification of stakeholder needs	Ineffective design; schedule delays
B	Budget limitations	Unable to complete prototyping and testing
C	Loss of funding	Drastic change in project plan required
D	Safety mishap during prototyping and testing	Injury or loss of life
E	Inability to engineer solution that meets all requirements	Unable to complete project and/or satisfy stakeholders
F	Inability to complete by project deadline	Unable to complete project due to hard deadline

Table 13-1 Initial Project Risks

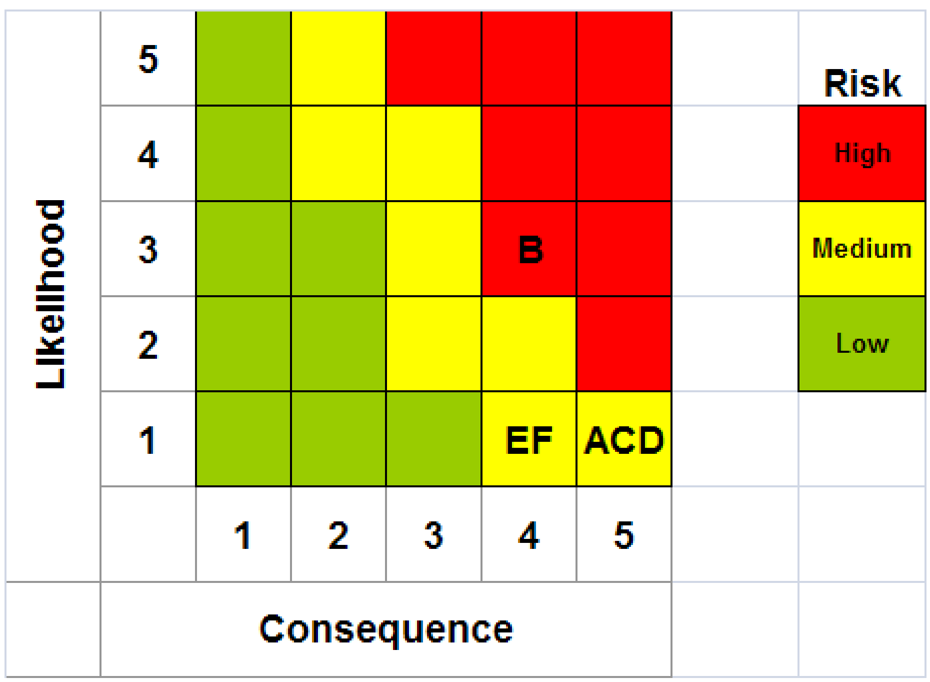


Figure 13-2 Risk Matrix

Appendix D – Preliminary Functional Analysis

No.	Level	Function	Definition	Rationale
1.0	1	Survive		
1.1	2	Operate in Environmental Conditions		
1.1.1	3	Operate on various soils		
	3	Operation different environments		
	3	Provide durability		
	3	Provide Fire Survival		
	3	Provide redundancy		
	3	Operate on uneven grounds		
	2	Storage in Environmental conditions		
2.0	1	Habitable		
2.1	2	Provide water		
2.1.1	3	Process Potable Water		
2.1.2	3	Store Potable Water		
2.1.3	3	Distribute Potable Water		
2.2	2	Allocate Power		
2.2.1	3	Generate Power		
2.2.2	3	Distribute External Power		
2.3	2	Protect Habitants		
2.3.1	3	Insulate Habitants		
2.3.2	3	Safeguard from Environment		
2.3.3	3	Furnish Ventilation		
2.3.4	3	Enable security		
2.3.4	3	Enable privacy		
2.4	2	Disperse Information		
2.4.1	3	Allow for inbound communications		
2.4.2	3	Allow for outbound communications		
2.5	2	Elementary Construction		
2.5.1	3	Easily Used		
2.5.2	3	Minimal Setup time		
2.5.3	3	Allot storage space		
2.6	2	Supply Lodging		
2.6.1	3	Enable Food Preparation		
2.6.2	3	Allot sleeping Provisions for Six		
2.6.3	3	Facilitate Scalability		
2.6.4	3	Enable Food Storage		
2.6.5	3	Enable Waste Disposal		

2.6.6	3	Enable Lighting		
3.0	1	Deploy		
3.1	2	Be transported		
3.1.1	3	Fit in standard shipping containers		
3.1.2	3	Withstand impact		
3.1.3	3	Allow fast deployment		
3.1.4	3	Transport by person(s)		
3.2	2	Store		
3.2.1	3	Utilize palletized packaging		
3.2.2	3	Allow long term storage		
3.2.3	3	Store sufficient quantity		

APPENDIX B: MISSION NEED STATEMENT

NAVAL POSTGRADUATE SCHOOL
SE311-101O CAPSTONE PROJECT
03 AUGUST 2011

MISSION NEED STATEMENT
FOR THE
HUMANITARIAN ASSISTANCE SHELTER SYSTEM

SUBMITTED BY: ______________________________ DATE:___________________
Cohort 311-101O
Naval Postgraduate School

CONCURRENCE: ______________________________ DATE:___________________
Brigitte Kwinn
Technical Advisor
Naval Postgraduate School

APPROVAL : ______________________________ DATE:___________________
Dr. David H. Olwell
Capstone Project Director
Naval Postgraduate School

CAPSTONE PROJECT SE311-101O
NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

Record of Changes:

Date	Revision	Reason for Change	Entered by:
05 FEB 11	1	Initial Submission	J. Brar
17 FEB 11	2	Updated Section 1.1 to add background. Section 2.1 was included as a primary need to include shelter. Section 3.8 was updated to refine requirement. Section 3.3 updated to include fire resistant materials. Section 3.10 updated for food preparation. Added Sections 4.5-4.7 for Color, Reparability, and Permanence of Marking.	J. Brar
20 FEB 11	3	Added EPA standards	J. Brar
28 FEB 11	4	Included performance metrics to MNS for primary needs	J. Brar
13 APR 11	5	Updated MNS based on Stakeholder rankings. Updated Section 1.1 with stakeholder descriptions. Re-ordered primary, secondary and tertiary needs using AHP results.	J. Brar
15 APR 11	6	Edited Section 1.1 in response to advisor feedback.	W. Kemmey
19 APR 11	7	Edited Table of Contents	J. Brar
22 APR 11	8	Updated MNS based on MNS analysis.	J. Brar
03 AUG 11	9	Final formatting for publication	J. Brar

Table of Contents

MISSION NEED STATEMENT FOR THE HUMANITARIAN ASSISTANCE SHELTER SYSTEM

Potential ACAT I through III

DATE: August 03, 2011

I CAPABILITY STATEMENT OF NEED

1.1 Mission Capability Gap. This Mission Need Statement (MNS) for the Humanitarian Assistance Shelter System (HASS) supports the Naval Post Graduate School (NPS) Capstone Project Guidance for 311-101O dated Jan 14, 2011. A capability gap exists in humanitarian shelters as there is not a prepackaged system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years). In order to support the future U.S Government humanitarian mission, a transition shelter is needed that is transportable, protective, adequately sized, reliable, maintainable, compatible with basic services, designed for an operational lifecycle of at least 2.5 years, securable, and private.

In the last ten years, a number of large natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, shelter and medical care have been lost and become critical needs for survival. The United States Government is often a first responder in these events.

To serve the needs of displaced victims of disaster, the HASS must deploy a shelter which can protect its occupants and serve their basic needs. Deployment includes set-up by untrained users with the assistance of locally-operating Non-Governmental Organizations. The shelter may be connected to other shelters in order to accommodate larger families or other flexible uses.

Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used.

Finally, the shelter system must be storable for long periods, and must be palletized for transport by land, air, or sea. Once deployed, the shelter must interface with its occupants, the environment, and possibly other connected shelters.

II PRIMARY CAPABILITY NEEDS

2.1 Operational Environment. The shelter solution shall be capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes. Capabilities of the shelter solution shall not be degraded when exposed to climatic conditions.

2.2 Operational Lifecycle. The HASS shall survive a shelf life in accordance with Section 3.10 of this Specification. The HASS system shall survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed. Operational duration is defined as any time outside of shelf time.

2.3 Transportability Needs. The shelter solution shall be able to be transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.

2.4 Shelter Capability. The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective). The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant.

2.5 Maintainability. All corrective maintenance shall be performed utilizing supplied general purpose tools.

2.5.1 Repairability. The HASS shall be designed to require no specialized tools for repairs. All tools required to assemble and make repairs shall be COTS. Tools necessary to perform the required repair tasks shall require no specialized training. Any repairs shall be performed by an untrained adult. Materials necessary for repair shall be included in the HASS.

2.6 Reliability. The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95% (Threshold) and 99% (Objective) of shelters with a lower bound 90% confidence interval. An essential functional failure is a failure of certain major components or systems of the HASS that cannot be repaired by the user. Major components are defined as any component in which a failure leads to the shelter being uninhabitable.

III SECONDARY CAPABILITY NEEDS

3.1 Operating Terrain. The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized

(Objective). The system shall be able to operate on a surface with a 12” slope over the 20’ length (Threshold).

3.2 Food Preparation and Storage. The Human Assistance Shelter System shall equip occupant(s) with resources for food preparation (Objective), distribution (Objective) and storage (Threshold). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption.

3.3 Communications. HASS shall incorporate provisions for one-way communication (Threshold) and two-way communication (Objective).

3.4 Lighting. The HASS shall be capable of providing natural light to the internal volume (Threshold). The HASS shall have provisions to adjust the amount of light entering the space. The HASS shall have provisions for artificial lighting (Objective).

3.5 Water Purification, Storage and Distribution. The HASS shall be able to purify indigenous water sources (Objective). The HASS shall have capacity to store water for consumption, personal hygiene and food preparation (Threshold).

3.6 Security. The HASS shall be securable against intruders (Objective).

3.7 System Safety. The HASS shall protect occupants and minimize exposure of the users, maintenance and handling personnel to safety hazards during its use, storage, and transport. The HASS shall include warning labels/indicators to warn of hazards. The HASS components shall be identified and located to prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death. The HASS shall provide occupants protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g., snakes, scorpions, rats, mosquitoes).

3.8 Human Engineering. The HASS shall be operable and maintainable by the full range of personnel (5th percentile female through 95th percentile male) in accordance with applicable sections of MIL-STD-1472 (See Section 5). The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and perform all required tasks. The HASS components shall be capable of 2 person lift.

3.9 Materials. The HASS shall not contain any materials hazardous to the occupant’s health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint

of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F.

3.10 Long Term Storage Needs. The HASS shall be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Applicable packaging shall be provisioned for long term storage.

3.11 Occupant Privacy. The HASS shall have provisions that allow dividing of internal volume for occupant privacy (Threshold = Objective).

IV TERTIARY CAPABILITY NEEDS

4.1 Ventilation Provisions. The HASS shall have provisions for natural ventilation (Threshold).

4.2 Scalability and Modularity. The HASS shall connect to another of the same type to increase the covered area. It shall be possible to connect the shelters using only the components and tools provided in the standard shelter package.

4.3 Marking. The HASS shall be marked in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft. (See Section 5)

4.4 Color. Military or camouflage colors shall not be used. Cultural and political sensitivities shall be taken into account, for example in the use of colors used in national or factional flags in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft. (See Section 5)

4.5 Shelter Components. The HASS shall maximize use of COTS components.

V REFERENCES

1. MIL-STD-1472D Department of Defense Design Criteria for Human Engineering

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2. SHELTER CENTRE Shelter Centre Transitional Shelter Standards Version 10B (2010).

APPENDIX C: CONOPS

NAVAL POSTGRADUATE SCHOOL

SE311-101O CAPSTONE PROJECT

11 July 2011

Concept of Operations

FOR THE

HUMANITARIAN ASSISTANCE SHELTER SYSTEM (HASS)

SUBMITTED BY: ______________________________ DATE: ____________________

Cohort 311-101O

Naval Postgraduate School

CONCURRENCE:______________________________ DATE: ____________________

Brigitte Kwinn

Technical Advisor

Naval Postgraduate School

APPROVAL: ______________________________ DATE: ____________________

Dr. David H. Olwell

Capstone Project Director

Naval Postgraduate School

CAPSTONE PROJECT SE311-101O

NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

Record of Changes:

Date	Revision	Reason for Change	Entered by:
28 FEB 11	1	Initial Submission	B. Williams
29 MAR 11	2	Updated Based on Stakeholder Feedback/Rankings	B. Williams
11 APR 11	3	Updated Based of Final MNS. Updated OV-5, OV-1, Operational scenarios, and base lined the document to the MNS.	B. Williams
14 APR 11	4	Minor technical updates	B. Williams
11 JUL 11	5	Updates to sections 1.1, 1.2, 1.4, 1.5	B. Williams

Table of Contents

List of Figures

1.0 Concept of Operations

1.1 System Objectives

The primary objective of the HASS is to reliably shelter its occupants; providing security and privacy through its design. It must be easily transportable and require minimal maintenance. Secondary and tertiary objectives include: cooking and storage of food, purification of water, minimal sanitation capability through the use of potable water, the ability to at least receive communications from the local government, artificial lighting, and the ability to scale the system's size as well as utilize local materials in its construction.

The HASS is intended to fill the current gap in the 6 month to 3 year shelter capability; deploying 6 months after the disaster event in replacement of emergency shelter kits. The HASS is intended to act as a transitional shelter system and will accommodate disaster victims until permanent housing is available. If no permanent housing is available, the HASS may be transformed into a more permanent shelter via the use of the shelter's frame and locally available construction materials.

1.2 General Implementation Strategy

When a disaster occurs, the US Government activates the military disaster relief organizations either at the request of the local government or in coordination with the local government. At the same time, non-military relief organizations are immediately mobilized once approval is granted from their liaisons on the ground. These immediate mobilizations result in emergency shelter kits reaching the disaster sites usually within 72 hours of the event. These emergency shelters are then utilized and modified by the users to last as long as possible. However, these emergency shelters are not intended to last beyond six months; leaving a shelter capability gap of 6 months to 3 years.

Therefore, before the 6 month after the disaster event or, or as soon as the coordinating relief agency deems necessary, the HASS is moved from its storage location via standard pallet to the disaster site or some intermediate distribution center where further transport awaits.

The HASS is delivered and set up on-site by untrained disaster victims or disaster relief personnel staffed by NGOs. The HASS is then inhabited by the displaced persons with their emergency supplies for a prescribed duration of 2.5 years after which the HASS may be disassembled and salvaged by the local population or utilized and transitioned into a more permanent form of housing. No part of the HASS is deemed recoverable by the stakeholder; the system is fire-and-forget.

The HASS will require minimal Preventive Maintenance Checks and Services (PMCS). The HASS will also be designed to meet a high operational reliability to achieve minimal repairs over its operational life cycle. Any repairs to critical components will be able to be completed by the untrained user with supplied tools, or the component will be designed to be easily replaced by the untrained user.

The HASS will also utilize a deployment and context driven design; meaning that if the stakeholder chooses, they will be able to deploy the HASS without some critical construction components (CCC) (e.g.,

wall or floors) to save cost. These CCCs will be assessed and chosen post-disaster based on what the stakeholder deems are the most locally salvageable materials. These CCCs will then be procured or salvaged by the user/stakeholder at or near the disaster site from. This not only saves the stakeholder acquisition and transportation costs, but allows more funds to be injected into the local economy if the CCCs are purchased from local suppliers. The local government will also coordinate with the supplying USA organization to ensure that the HASS kits which they will receive are configured to the maximum extent possible for the local government's specific operational environment thus saving costs associated with the transportation and implementation of unnecessary HASS components or features.

The HASS's general implementation strategy can be graphically viewed in the OV-1 below (Fig 1).

Figure 1: HASS Operational View (OV-1)

1.3 Organizations and Activities

Local Governments

Local governments are responsible for letting the US Government and NGOs know that aid is needed and would be welcome. They should also make known the type of aid (shelter, food, water, etc.) needed and some estimate on quantity required. Local governments should also provide information on any salvageable materials that may be used as CCCs in the HASS as well as define the operational scenario in which the HASS will be deployed for purposes of correctly configuring the HASS kit. They should provide all possible assistance in making a location close to the disaster site available as a central point for collection and dissemination of the aid received. The local government should provide for the security of the aid supplies before distribution to prevent pilferage by displaced persons or their citizens. They should also provide security and guide personnel to escort HASS shipment to its final set-up location. They are responsible for maintaining law and order of their citizens so that aid workers are safe.

US Government

The US Government should be receptive to the request for aid from the local governments. They should make arrangement to expeditiously deliver the requested aid to the site specified. They are responsible for the conduct of their citizens and to respect the customs of the local population.

On-Land Distribution Center

The on-land distribution center, if used, must be provided to the US government for distribution of the HASS and other related supplies. The local government is responsible for aiding in this distribution to the maximum extent possible in order to expedite the process. This may entail providing such information as affected areas, population amounts, distribution routes, etc. This may also entail providing distribution and setup means such as trucks or available personnel.

Transportation

The HASS shall be moved from its continental US storage location by whatever means (military or civilian; ground, air, rail, etc) expeditiously and economically to the nearest port or airfield of embarkation. The HASS will be transported on standard wooden pallets and multiple systems may be transported in standard ISO shipping containers concurrently. The ship or aircraft will transport the HASS to the disaster site or land based distribution center, as appropriate. If off-loaded at the land-based distribution center, further transportation from there will be required to the disaster site via ground transportation or helicopter. Regardless of the mode of transportation, the HASS will be delivered to as close to the set-up site as possible.

Set-up

The HASS is designed to be easily set-up by untrained personnel using common non-specialized tools and accessories provided with the HASS. Site preparation is preferred but not limited to having a

relatively level clear space, preferable on solid soil. The HASS can be transported and assembled by a two person crew.

1.4 Interactions and Responsibilities

Stakeholders

Stakeholders are responsible for procuring and delivering the HASS to the users' disaster site. The stakeholders will aid the users in any means possible to expedite the setup and utilization of the HASS system for all displaced users.

Users

The users are the displaced victims of the disaster. Their initial responsibility is to set-up the HASS upon receipt. The users are also in charge of providing or seeking out if they desire any additional inputs or supplies that may integrate into the HASS such as CCCs (if applicable), food, water, fuel for cooking, or general goods. While residing in the shelter, the user is responsible for maintaining the unit to include preventive maintenance and repairs. When notified that a more permanent shelter is available, the users should avail themselves of this improved habitat. If permanent shelter is not available, it is the users' responsibility to transform the HASS into a more permanent type of shelter if the users so desire.

1.5 Constraints affecting the Systems

Constraints affecting the systems

- The HASS is not intended to be re-used by the stakeholder.
- The HASS components are weight and size limited.
- The HASS has a lifespan (expiration date) when used in a non-permanent configuration.
- The HASS requires inputs such as water, food, possible provisions for cooking, or other items for personal use (linens, sanitary items, etc.) to meet operational requirements.
- The HASS is intended to house no more than 10 adults.
- The HASS has prescribed climatic and environmental conditions in which it can be deployed.
- The HASS is only rated to provide a certain quantity of purified water per day.
- The HASS must be assembled by untrained adults.

1.6 Processes for System Initiation and Development

The designers intend for the system to be safe, easy to use, cost-effective and useful in virtually any kind of disaster response environment. The system can be manufactured by any entity which has the ability to obtain and work with the materials specified. While initial design and manufacture will take place in the United States (US), it is likely that additional development and enhancement of the product will take place outside the US.

Initial product development and modification will be accomplished following operational test and evaluation. It is envisioned that further feedback and development will occur once the product has

been deployed and used in an actual disaster scenario. The information obtained following real-world system employment will be vital to product development.

1.7 Maintenance, Repair, and Disposal

The maintenance actions required by the HASS will be minimal and will require no specialized training or tools to complete. Maintenance actions will primarily consist of preventative maintenance such as cleaning, removing snow loads, securing the structure for high winds or dust, and other such actions associated with operating the HASS in external elements. All maintenance actions will be completed by the users.

When repair actions are required by the HASS, they will be minimal and will require no specialized training or tools to complete. The HASS will also limit substantial repair actions through its design, which will ensure 95%-99% of shelters will complete 2.5 years of operation without a major functional failure with a lower bound confidence interval of 90%. Major components include coverings, liners, fabrics, structural components, or any other component of the structure which is associated with providing the primary needs of the HASS as defined in the MNS. All repair actions will be performed by the users or trained personnel when available.

The responsibility of disposing of the HASS falls on the users or the users' local government. From the stakeholder's perspective, the HASS is an expendable system. The HASS may be disposed of in any municipal waste facility because it will be constructed of non-toxic materials.

1.8 HASS Operational Activity Hierarchy Diagram (OV-5)

Figure 2 below depicts the HASS' major operational activities in chronological order. According to the MNS, the main activities the HASS must perform are: Deploy, Operate, Protect, Serve, and Use Shelter.

"Deploy" consists of activities associated with the deployment, transport, assembly and scalability of the system. "Operate" refers to activities associated with the utilization of the shelter and its subsystems. "Protect" includes activities associated with safeguarding of the occupants and their possessions within the shelter, contributing to a livable and safe atmosphere. "Serve" refers to activities associated with HASS' provided components. These components are not part of the shelter's physical structure, but are intended for integration with the HASS to provide users with capabilities necessary to their health and survival. "Use Shelter" references activities associated with the utilization and maintenance of the shelter structure itself.

Although it is not considered a stakeholder need, the "Dispose" activity will be performed by the HASS and the system user. From the stakeholder's perspective, the HASS is a disposable (not for reuse) system, but the user or the local government will still be ultimately responsible for its disposal and/or salvage.

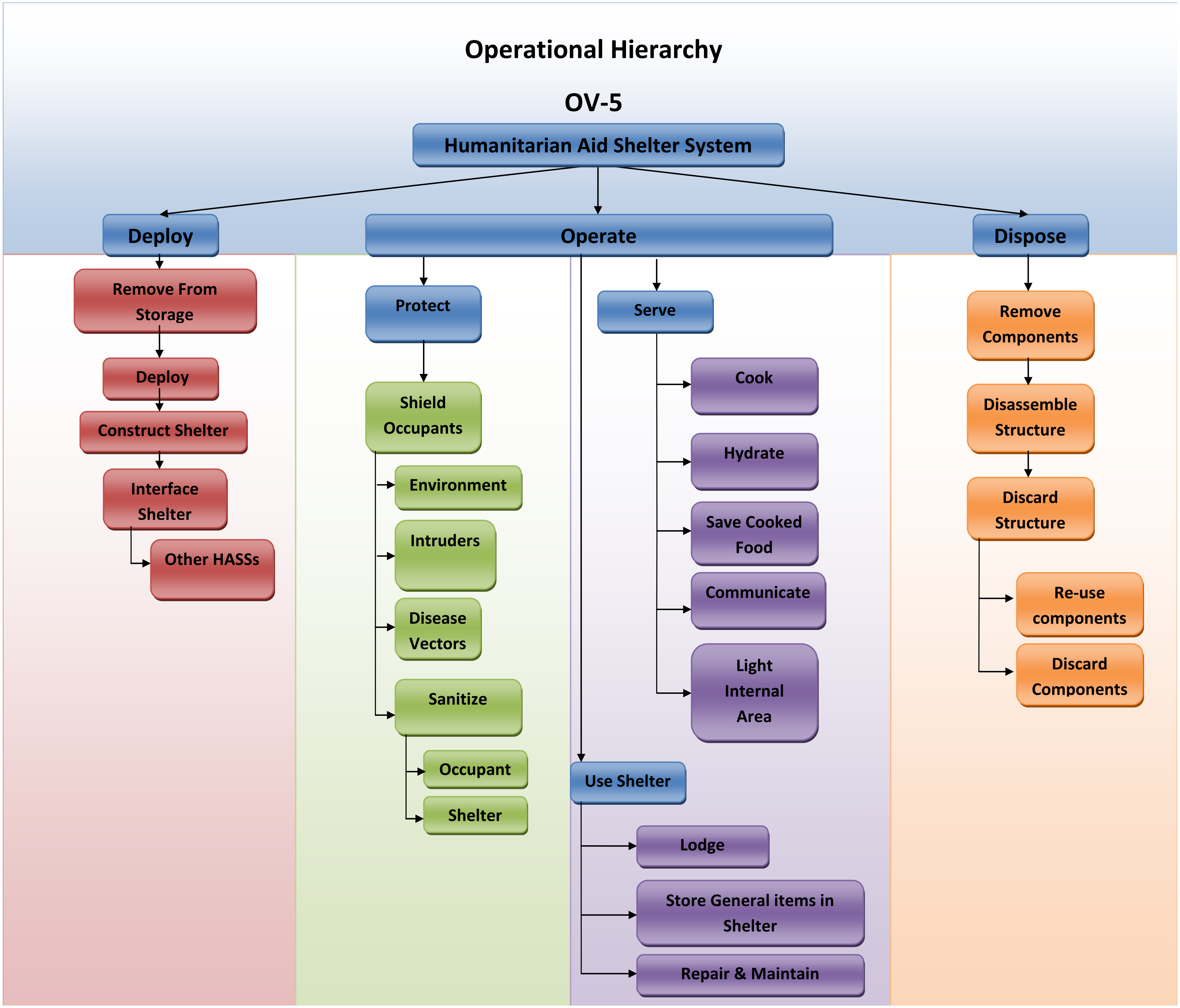


Figure 2: HASS Operational Hierarchy (OV-5)

2.0 Operational Environments

While the HASS is intended to operate in a variety of austere environmental conditions, specific research has been conducted to determine the true environmental conditions in which it may be deployed. The specific environments researched are: Tropical, cold weather, and desert.

The various physical parameters imposed on the HASS from these environments will be considered in its design, and it will therefore be designed to operate, but not limited to operate in such common environmental conditions.

The specific environments were researched using online weather databases and can be viewed in section 2.1[1,2]. Challenges posed to the HASS due to each operational environment are also discussed.

2.1 Tropical, Cold Weather, and Desert Operational Environments

Environmental Type: Tropical

Example Location: Haiti

Temperature: 70-80

Humidity: High. 70% Average

Typical Weather: Sunny. Rainy Season May-July-130mm average per month

Severe Weather: Hurricanes

Wind: Mild. 10 MPH Average

Chance of Sun: 50-80%

Operational Environment Challenges posed on Shelter:

- High temperatures can result in dehydration and food spoilage.
- Likelihood of rain can cause flooding. Flooding can cause disease by washing trash and sewage into living spaces.
- Likelihood of high winds or hurricane can destroy shelter.

Environmental Type: Cold Weather

Example Location: Northeast U.S.A

Temperature: -25 - 40

[1] http://www.weatherbase.com/weather/weatherall.php3?s=66326&refer=&units=us
[2] http://www.zoover.co.uk/egypt/egypt/cairo/weather

Humidity: Low. 5%-40% Average

Typical Weather: Overcast. Average rain per month = 4in. Average snow per month = 12 in.

Severe Weather: Blizzard or Nor'easter

Wind: Mild. 16 MPH Average

Chance of Sun: 50%

Operational Environment Challenges posed on Shelter:

- Cold Temperatures can freeze internal water and cause hypothermia and death.
- High winds and snow loads can damage shelter.
- Snow and rain can cause unsanitary and wet conditions within the shelter. Can cause hypothermia if no heat is provided.
- Blizzard conditions can prevent egress to and from shelter.

Environmental Type: Desert

Example Location: Middle East-Northern Sinai Peninsula/Egypt

Temperature: 60-100

Humidity: High. 70%-80% Average

Typical Weather: Sunny. Average rain per month = .1in.

Severe Weather: Dust Storm

Wind: Low. 8 MPH Average

Chance of Sun: 85%

Operational Environment Challenges posed on Shelter:

- High solar loads can increase temperature in shelter to dangerous levels.
  High temperatures can result in dehydration and food spoilage.
- Dust can create unsanitary conditions and cause breathing difficulties.

3.0 Operational Scenarios

The sections below outline possible operational scenarios that the HASS may encounter. These operational scenarios include transportation, setup, logistics, and use.

3.1 Best Case Scenario

Transportation	The HASS is mobilized at its storage location, approximately 6 months after a disaster event, when a request for shelter type aid is received. The stakeholder supplying the HASS works with the local government at the disaster site to secure an on-land distribution center. The HASS is then transported by plane or ship to the on-land distribution center. From the distribution center the HASS is then transported to the disaster site by truck, train, or any other means available where its distribution to the users is facilitated by the local government or NGOs.
Setup	At the disaster site the HASS is then disassembled into its constituent components, carried to its assembly site, and assembled by the user using tools supplied with the HASS. Local CCCs may also be incorporated if provided.
Logistics	Around six months after a disaster event, the local government at the disaster site contacts the USA to request transitional shelters. Salvageable materials still at the disaster site are noted, and a determination is made prior to transportation by both the local government and the stakeholder as to what level of CCCs will be incorporated into the HASS' construction. These CCCs, if chosen to be supplied at the HASS' assembly site, may be salvaged materials or materials purchased locally. The local government will also coordinate with the supplying USA organization to ensure that the HASS kits which they will receive are configured to the maximum extent possible for the local government's specific operational environment; thus saving cost. Any additional inputs/outputs to the shelter such as water, food, and waste disposal will be provided and managed by the local government or NGOs. Additional external security will also be provided by the local government during transportation and distribution of the HASS. Resupply efforts are conducted daily and local distribution centers are available for supplies.
Use	The HASS will be deployed around six months after a disaster event and used by the user for a maximum of 2.5 years. During this time of operation the HASS will experience an operational reliability of 99% in reference to its major components. During the HASS' operation, the user will be able to cook food, clean the HASS, sanitize, store items, purify water to an extent, communicate via radio, and live comfortably in most environmental conditions. The HASS will also provide security measures to the extent that it will protect the users and their belongings from easy theft and intrusion. The tools and materials necessary to perform minimal PMCS and repairs will be provided to the users with the HASS and they will perform these measures on their own as necessary.

3.2 Normal Case Scenario

Transportation	The HASS is mobilized at its storage location, approximately 6 months after a disaster event, when a request for shelter type aid is received. The stakeholder supplying the HASS works with the local government at the disaster site to secure an on-land distribution center. The HASS is then transported by ship to the on-land distribution center. From the distribution center the HASS is then transported to the disaster site by truck, train, or any other means available where it's distributed to the users.
Setup	At the disaster site the HASS is then disassembled into its constituent components, carried to its assembly site, and assembled by the user using tools supplied with the HASS. Local CCCs may also be incorporated if provided.
Logistics	Around six months after a disaster event, the local government at the disaster site contacts the USA to request transitional shelters. Salvageable materials still at the disaster site are noted, and a determination is made prior to transportation by both the local government and the stakeholder as to what level of CCCs will be incorporated into the HASS' construction. These CCCs, if chosen to be supplied at the HASS' assembly site, may be salvaged materials or materials purchased locally. The local government will also coordinate with the supplying USA organization to ensure that the HASS kits which they will receive are configured to the maximum extent possible for the local government's specific operational environment; thus saving cost. Any additional inputs/outputs to the shelter such as food, water, and waste disposal will be provided and managed by the local government or NGOs. Resupply efforts are conducted on a weekly basis and are somewhat disorganized.
Use	The HASS will be deployed six months after a disaster event and used by the user for a minimum of 2.5 years. During this time of operation the HASS will experience an operational reliability of 95% in reference to its major components. During the HASS' operation, the user will be able to cook food, clean the HASS, sanitize at certain intervals, store items, purify water to an extent, and live comfortably in most environmental conditions. The HASS will also provide security measures to the extent that it will protect the users and their belongings from easy theft and intrusion. The tools and materials necessary to perform minimal PMCS and repairs will be provided to the users with the HASS and they will most likely perform these measures on their own as necessary.

3.3 Worst Case Scenario

Transportation	The HASS is mobilized at its storage location, approximately 6 months after a disaster event, when a request for shelter type aid is received. The HASS is then transported by ship to the requesting nation where it encounters little infrastructure for distribution, so an ad-hoc distribution center must be setup. From the distribution center the HASS is then transported to the disaster site by truck, train, or any other means available where it's distributed to the users. Certain percentages of HASSs in route to the disaster site will be pilfered or stolen by locals. Delays in transportation to the disaster site may extend the deployment timeline to later than six months after the disaster event.
Setup	At the disaster site the HASS is then disassembled into its constituent components, carried to its assembly site, and assembled by the user using tools supplied with the HASS. Damaged, stolen, or pilfered components of newly arriving HASSs may result in insufficient materials to construct the HASS, or limit its capabilities.
Logistics	Around six months after a disaster event, the local government at the disaster site contacts the USA to request transitional shelters. The local government will coordinate with the supplying USA organization to ensure that the HASS kits which they will receive are configured to the maximum extent possible for the local government's specific operational environment; thus saving cost. Any additional inputs/outputs to the shelter such food and water will be infrequently provided by the local government or NGOs. Minimal resupply efforts are performed if at all with no organization whatsoever. Most supplies are either stolen or pilfered during resupply efforts.
Use	The HASS will be deployed six months or more after a disaster event and used by the user for a maximum of 5 years. During this time of operation the HASS may experience an operational reliability of 95% in reference to its major components; depending on the completeness of the HASS at its time of construction. During the HASS' operation, the user will be able to cook food, store items, purify water to an extent, and live comfortably in most environmental conditions if sufficient materials and supplies are provided to ensure most capabilities are met. The HASS may also provide minimal security measures in its operational environment to the extent that it will protect the users and their belongings from easy theft and intrusion if sufficient materials and supplies are available upon setup. The tools and materials necessary to perform minimal PMCS and repairs may be provided to the users with the HASS and they will most likely not perform these measures on their own.

APPENDIX D: SYSTEM SPECIFICATION

NAVAL POSTGRADUATE SCHOOL
SE311-101O CAPSTONE PROJECT
25 JUNE 2011

SYSTEM PERFORMANCE SPECIFICATION
FOR THE
HUMANITARIAN ASSISTANCE SHELTER SYSTEM (HASS)

SUBMITTED BY: ______________________________ DATE:___________________
Cohort 311-101O
Naval Postgraduate School

CONCURRENCE: ______________________________ DATE:___________________
Brigitte Kwinn
Technical Advisor
Naval Postgraduate School

APPROVAL : ______________________________ DATE:___________________
Dr. David H. Olwell
Capstone Project Director
Naval Postgraduate School

CAPSTONE PROJECT SE311-101O
NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

Humanitarian Assistance Shelter System (HASS)

Record of Changes

Date	Revision	Reason for Change	Entered by:
08 JUN 11	1.0	Initial Release	J.Brar
05 AUG 11	2.0	Release	B. Williams
09 AUG 11	2.1	Release Mod 1	B. Williams
13 AUG 11	2.2	Release Mod 2	J. Wareham
17 AUG 11	3.0	Format for Publication	D. Hory

Humanitarian Assistance Shelter System (HASS)

CONTENTS

PARAGRAPH PAGE

Humanitarian Assistance Shelter System (HASS)

List of Tables

Humanitarian Assistance Shelter System (HASS)

1 SCOPE

1.1 Scope.

This system specification defines the performance, design, environmental, and verification requirements for the Humanitarian Assistance Shelter System (HASS). The HASS is a proposed concept intended to provide shelter for disaster victims.

The HASS is a transportable, protective, adequately sized, reliable, maintainable, compatible with basic services, and intended for an operational lifecycle of at least 2.5 years, securable, and private system.

1.2 Background.

In the last ten years, a number of large natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, and shelter have been lost and become critical needs for survival. The United States Government is often a first responder in these events.

To serve the needs of displaced victims of disaster, the HASS must deploy and protect its occupants and serve their basic needs. Deployment includes set-up by untrained users with the assistance of locally-operating Non-Governmental Organizations. The shelter may be connected to other shelters in order to accommodate larger families or other flexible uses.

1.3 System Overview.

In order to support possible future U.S Government and NGO humanitarian missions, a transition shelter is needed. A capability gap exists in humanitarian shelters as there is not a universally accepted system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years).

Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used.

Finally, the shelter system must be storable for long periods, and must be palletized for transport by land, air, or sea. Once deployed, the shelter must interface with its occupants, the environment, and possibly other connected shelters.

2 APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in Sections 3 or 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Sections 3 or 4 of this specification, whether or not they are listed.

2.2 Government Documents

2.2.1 Specifications, Standards, and Handbooks.

The following specifications, standards, and handbooks of the exact revision listed below form a part of this document to the extent specified herein.

DEPARTMENT OF DEFENSE STANDARDS
(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

MIL-STD-810G	Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests
MIL-STD-130M	Department of Defense Standard Practice-Identification Marking of U.S. Military Property
MIL-STD-1472D	Department of Defense Design Criteria for Human Engineering

2.2.2 Other Government Documents, Drawings, and Publications.

The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

FEDERAL STANDARDS
(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

FED-STD-595C	Colors Used in Government Procurement

Humanitarian Assistance Shelter System (HASS)

US ARMY
(Copies of these documents are available online at Army Publishing Directorate (www.apd.army.mil) or Army at Army Knowledge Online (www.us.army.mil)).

TB-MED 577 (2010)	Sanitary Control and Surveillance of Field Water Supplies.
US ARMY	U.S. Army's 1998 Anthropometric Survey
US ARMY	Operational Forces Interface Group – Vehicular Mounted Combat Cooling System (VMCCS).Natick Soldier Research, Development and Engineering Center. Internal Report, January 8, 2009.)

NATIONAL SCIENCE FOUNDATION (NSF)
(Copies of these documents are available online at http://www.nsf.gov)

NSF Protocol 231	Microbiological Water Purifiers

OCCUPATIONAL SAFETY AND HEALTH ASSOCIATION (OSHA)
(Copies of these documents are available online at http://www.osha.gov)

OSHA 1926.152	Safety and Health Regulations for Construction
OSHA CFR 29	OSHA Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 dated 1998

2.3 Non-Government Publications.

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNATIONAL STANDARDS ORGANIZATION
(Copies of these documents are available online at http://www.iso.org)

ISO 3864-2:2004	Graphical Symbols-Safety Colors and Signs
ISO 1496-1:1990	Standard for Forklift Pockets

AMERICAN NATIONAL STANDARDS INSTITUTE
(Copies of these documents are available online at http://www.ansi.org)

ANSI/UL 263 (2001)	Fire Resistance Ratings

AMERICAN SOCIETY FOR TESTING AND MEASUREMENT (ASTM)
(Copies of these documents are available online at http://www.astm.org)

ASTM F-1275-03	Standard method for performance of Griddles
ASTM D6413-94	Vertical Flame Chamber

OXFAM
(Copies of these documents are available online at http://publications. oxfam.org.uk)

Shelter Project - Transitional Settlement Displaced Populations, 2005 (http://postconflict.unep.ch/liberia/displacement/documents/Corsellis_Vitale_Transition_Settlement_Displaced_Populatio.pdf)

SHELTER CENTRE

Shelter Centre Transitional Shelter Standards Version 10B (2010).

SPHEREPROJECT

Volume amounts per Sphere project: http://www.sphereproject.org/

USA CARGO CONTROL

E-Track system (http://www.usacargocontrol.com)

Workplace Hazardous Material Identification System (WHMIS classification system)
http://www.hc-sc.gc.ca/ewh-semt/pubs/occup-travail/ref_man/ref_manual_index-eng.php

2.4 Order of Precedence.

In the event of a conflict between the text of this document and references cited herein, this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations.

3 REQUIREMENTS

3.1 General.

This section defines the performance, design, and environmental requirements for the HASS.

3.2 Environmental Operating Conditions.

The HASS shall be capable of operations in climatic conditions including rain, snow, salt fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes. Capabilities of the shelter solution shall not be degraded when exposed to climatic conditions.

3.2.1 Temperature.

The HASS shall operate at normal capacity without degradation in ambient temperatures ranging from –22o F to 131o F (Threshold) and 144 o F (Objective) (–30o C to 55o C [Threshold] and 62.2o C [Objective]).

3.2.2 Rain.

The HASS shall operate without degradation in non-accumulating rain conditions with rainfall rates up to 2.5 inches per hour (Threshold) and 4 inches per hour (Objective).

3.2.3 Sand Conditions.

The HASS shall operate without degradation in blowing sand conditions with sand concentrations up to 1.1 ± 0.3 grams per cubic meter (0.033 ± 0.0075 grams per cubic foot), concurrent with particle size between 150 to 850 micrometers, and concurrent with wind speeds up to 40 miles per hour in accordance with MIL-STD-810G.

3.2.4 Dust Conditions.

The HASS shall be capable of operation without degradation in blowing dust conditions with particle size less than or equal to 149 micrometers concurrent with wind speeds up to 20 miles per hour in accordance with MIL-STD-810G.

3.2.5 Icing Conditions.

The HASS shall operate without degradation in freezing rain/ice conditions with ice accumulations of .5 inches (Threshold) and 3 inches (Objective).

3.2.6 Humidity.

The HASS shall operate without degradation in high humidity conditions of up to 100% Relative Humidity (RH) in accordance with MIL-STD-810G.

3.2.7 Fungus.

The HASS shall operate without degradation after exposure to fungus. The HASS shall experience only a Light (Threshold) and trace (Objective) amount of Fungus growth on the shelter as defined in MIL-STD-810G through its operational lifecycle.

Humanitarian Assistance Shelter System (HASS)

3.2.8 Mold.

The HASS shall operate without degradation through its operational lifecycle after exposure to mold. The HASS shall be mold resistant consistent with best commercial practices.

3.2.9 Mildew.

The HASS shall operate without degradation through its operational lifecycle after exposure to mildew. The HASS shall be mildew resistant consistent with best commercial practices.

3.2.10 Wind.

The HASS shall be capable of operation without degradation in high wind conditions with wind speeds up to 40 miles per hour (Threshold) and 100 miles per hour (Objective).

3.2.11 Snow.

The HASS shall be capable of sustaining snow loads up to .0435 psi (Threshold) and .058 psi (Objective) without damage.

3.2.12 Salt Fog.

The HASS shall operate in salt fog conditions without degradation (see degradation definition below) in accordance with MIL-STD-810G. Salt fog degradation is defined as reducing the yield strength of the material by no more than 10% of any structural component (Threshold) and 5% (Objective).

3.3 Performance Requirements.

3.3.1 Operational Lifecycle.

The HASS system shall survive an operational usage duration of 2.5 years (Threshold) and 5 years (Objective) once deployed. Operational usage duration is defined as any time outside of pre-deployment storage time.

3.3.2 Operating Terrain.

The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized (Objective). The system shall be able to operate on a surface with a 12” slope over the 20’ length (Threshold).

3.3.3 Water-resistant.

The HASS, without additional equipment or preparation, shall be water-resistant to preclude internal damage from the applicable environmental operating requirements contained in Section 3.2 of this specification.

Humanitarian Assistance Shelter System (HASS)

3.3.4 Reliability and Maintainability.

The HASS System shall be reliable so as to not require a supply chain. The HASS System shall require minimal preventive and corrective maintenance throughout its lifecycle

3.3.4.1 Reliability.

The HASS shall demonstrate a 95% (T) and 99% (O) reliability over the intended lifecycle (2.5 years) with a lower bound 90% confidence interval.

3.3.4.2 Preventive Maintenance in Storage.

Any preventive maintenance actions performed on the HASS in storage shall be performed by trained personnel requiring only COTS tools. Preventive maintenance actions in storage are defined as detailed inspections/system checkout and scheduled safety inspections.

3.3.4.3 Preventive Maintenance in Operations.

Any preventive maintenance actions performed on the HASS in operations shall be performed by an untrained adult with basic tools from the supplied general purpose tool kit. Preventive maintenance actions in operations are defined as visual inspections and external adjustments.

3.3.4.4 Corrective Maintenance.

All corrective maintenance shall be performed utilizing supplied general purpose tools. HASS shall be designed to require no specialized tools for repairs. All tools required to make repairs shall be COTS. Tools necessary to perform the required repair tasks shall require no specialized training. Any repairs shall be performed by an untrained adult. Materials necessary for repair shall be included in the HASS.

3.3.4.5 Mean Time Between Maintenance.

The HASS shall have a mean time between maintenance (MTBM) of no less than 615 hours.

3.3.4.6 Mean Active Maintenance Time.

The HASS shall have a mean active maintenance time (M) of no more than 35 minutes.

3.3.5 Vibration.

The HASS shall operate at normal capacity without degradation after exposure to the following vibration profile in accordance with MIL-STD-810 G section 514.6.

RMS Acceleration:1 (Grms):
Vertical - 1.04;
Transverse - 0.20;
Longitudinal - 0.74.

Velocity (in/sec) (peak single amplitude):1
Vertical – 7.61;

Humanitarian Assistance Shelter System (HASS)

Transverse – 1.21;
Longitudinal – 4.59.

Displacement (in) (peak double amplitude):1
Vertical – 0.20
Transverse – 0.02;
Longitudinal – 0.11.

3.3.6 Altitude.

The HASS shall be capable of transport without degradation at altitudes from 0 to 35,000 feet above sea level. The system shall be operable from 0 to 10,000 feet above sea level. Procedures for high altitude operation (if different than sea level operation) shall be provided.

3.3.7 Long Term Storage Needs.

The HASS shall be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Applicable packaging of the HASS shall be provisioned for 10 years of storage. Functional capacity is defined as the HASS' ability to operate in conformance with environmental conditions specified in section 3.2.

3.3.8 HASS Assembly.

Assembly of the HASS shall be performed utilizing supplied general purpose tools. The HASS shall require no specialized tools for assembly. All tools required to assemble the HASS shall be COTS. Tools necessary to perform the assembly tasks shall require no specialized training. All assembly tasks shall be performed by an untrained adult.

3.3.9 HASS Operation.

Operation of the HASS shall require no specialized skills or training. Operation is defined as using the HASS structure or its components for their intended purposes in their prescribed operational environments.

3.4 Design

3.4.1 Shelter Capability.

The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective). The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant. Covered floor space is defined as floor space which separates the HASS' users from the environmental operating conditions stated in section 3.2.

3.4.2 <u>Materials.</u>

HASS shall not contain any materials hazardous to the occupant's health and environment; precluding materials classified as Class A, Class C, Class D, Class E, and Class F per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system. The HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice.

3.4.2.1 <u>HASS Modification.</u>

The HASS shall be capable of being modified leveraging recycled, recovered, locally available, or environmentally preferable materials.

3.4.2.2 <u>COTS Material and Component Selection.</u>

The HASS shall be comprised of 90% (T) and 100% (O) COTS components. COTS components are defined as readily available components or assemblies which require no modifications or development to integrate.

3.4.2.3 <u>Flammable Liquids and Materials.</u>

The HASS shall not include flammable liquids and materials in a deliverable end item in accordance with OSHA 1926.152 Class 1A, 1B and 1C.

3.4.2.4 <u>Toxicity of Materials.</u>

The HASS shall not cause skin irritations or other injuries, and shall not produce vapor hazards, including the emission of toxic or noxious odors to users under all environmental conditions.

3.4.2.5 <u>Treatment and Painting of Materials.</u>

Any combustible materials shall be treated as to minimize their combustibility so that char length does not exceed 7 inches. Combustibility is defined as any material having a rating of Class II, or III IAW OSHA 1926.152 flammability and combustibility classification system.

3.4.3 <u>Color.</u>

The HASS shall be colored white, Number FS 37925, in accordance FED-STD-595(1994). Exceptions may be made where cultural and political sensitivities are taken into account. For example, in the use of colors used in national or factional flags in accordance with Transitional Shelter Standards Version 10B (2010).

3.4.4 <u>Labeling.</u>

The HASS shall be marked in accordance with Transitional Shelter Standards Version 10B (2010). Any marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive in accordance with MIL-STD-130M, Section 4.1-

4.3. Ordinary usage, handling, storage, and the like, of a product are considered in the determination of the permanency of a marking.

3.4.5 Transport.

In transport configuration, the HASS' pack-out configuration width shall be small enough to fit through a standard 8'x8'x20' ISO container. In transport mode, the HASS shall tie down in a standard 8'x 8'x 20' ISO container utilizing an E-Track system (http://www.usacargocontrol.com) with ratchet straps without causing any damage to the HASS. In transport mode, the HASS shall be capable of surviving the vibration requirements in section 3.3.5 without any damage or degradation of performance.

3.4.5.1 Transportation Configuration.

Transportation configuration is defined in Figure 1.1. In its transportation configuration, 4 HASSs shall fit on 1 standard pallet (Objective) and 1 HASS on 3 standard pallets (Threshold). Standard pallet size is defined as 48" x 45" with standard forklift pocket dimensions IAW ISO Standard 1496-1 (1990).

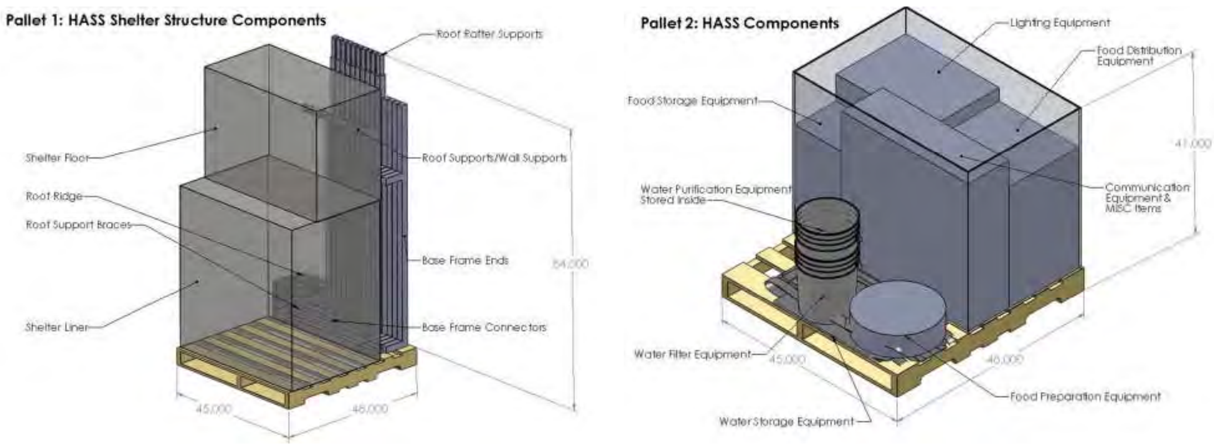


Figure 1.1: Example Transportation Configuration

3.4.5.1.1 Forklift.

The HASS, in transportation configuration, shall be capable of being lifted into and out of standard shipping containers by a forklift without damage.

3.4.6 Food Preparation, Storage and Distribution.

The HASS shall equip occupant(s) with resources for food preparation (Objective), distribution (Objective) and storage (Threshold). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption in a sanitary manner. Food storage is defined as storing hot, cold, cooked, solid, or liquid food for consumption by the user.

3.4.6.1 Food Storage Containers.

Food storage containers shall be air-tight and water proof; as to maximize the ability to preserve the stored food while keeping it uncontaminated.

3.4.6.1.1 Food Storage Container Volume.
Food storage containers shall have a volume of 6 qt. (ea).

3.4.6.1.2 Food Storage Container Quantity.
Four storage containers of identified volume shall be provided.

3.4.6.2 Food Preparation & Distribution Kits.

Food preparation & distribution kits shall meet Oxfam Transitional Settlement Displaced Populations specifications dated 2005 in relations to kit contents (Objectives) as shown in below Table 3.1, Food Preparation & Distribution Kit Contents.

Table 3.1 - Food Preparation & Distribution Kit Contents

ITEM	Quantity	Description
1	1 for 5 or less occupants 2 for more than 5 occupants	Large Cooking Pot
2	2 for 5 or less occupants 4 for 5 or more occupants	Medium Cooking Pots
3	1 per occupant	Bowls
4	1 per occupant	Plates
5	1 per occupant	Cups
6	1 per occupant	Knives
7	1 per occupant	Forks
8	1 per occupant	Tablespoons
9	1 per System	Kitchen Knife
10	1 for 5 or less occupants	Bucket

3.4.6.2.1 Food Preparation & Distribution Kit Material.
All food preparation & distribution kit contents shall be constructed of stainless steel, in accordance with Oxfam Transitional Settlement Displaced Populations specifications dated 2005 (Objective).

3.4.6.3 Food Preparation.

The HASS shall have provisions for food preparation. (Objective). Food preparation is defined as the capability to boil, braise, pan fry and griddle.

3.4.6.3.1 Food Preparation Equipment Heat Transfer Performance.
Food preparation equipment shall be capable of bringing 2.5 gallons of water (which is either in direct contact with the equipment or in a separate cooking vessel) to a boil (212F) from 70F in ambient temperatures equal to or greater than 32F in 30 minutes (Objective).

Humanitarian Assistance Shelter System (HASS)

3.4.6.3.2 Food Preparation Equipment Surface Area Performance.
Food preparation equipment shall be capable of bringing 1.5 sq. ft. of an unloaded cooking surface (for braising, pan frying, and griddling) to a temperature of 375F in ambient temperatures equal to or greater than 32F with a cooking surface temperature equal to the ambient temperature in a maximum of 15 minutes (Objective). Food preparation equipment shall be capable of a cook time of 10 minutes per load and a maximum recovery time of 5 minutes between loads IAW ASTM F 1275-03(2008) section 10.7 (Cooking energy efficiency and production capacity) (Objective).

3.4.6.3.3 Food Preparation Equipment Cooking Surface Material.
Food preparation equipment cooking surfaces areas shall be made of corrosion resistant steel (Objective).

3.4.6.3.4 Food Preparation Equipment Efficiency.
Food Preparation Equipment Net Efficiency shall be 40% (threshold) and 50% (Objective). Food Preparation Net efficiency is defined as 2946.5 Btu divided by total energy content of fuel used to bring 2.5 gallons of water to a boil.

3.4.7 Water Purification, Storage, and Distribution.

The HASS shall be able to store (Threshold), distribute (Threshold), and purify (Objective) water from indigenous fresh water sources. Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.

3.4.7.1 Water Purification Temperature.

The HASS shall be capable of purifying indigenous fresh water sources at temperatures between 32F and 170F (Objective).

3.4.7.2 Water Purification Rate.

The HASS shall be capable of purifying indigenous fresh water sources at a rate of 5 L/Day per user (Objective).

3.4.7.3 Water Purification Quality.

The HASS shall be capable of purifying indigenous fresh water sources IAW NSF P231 and TB-MED 577 (2010) to meet DOD 5 L/Day tri-service water quality standards for the duration of the operational cycle (Objective).

3.4.7.4 Water Storage Volume.

The HASS shall have capacity to store 20 liters of water for consumption, personal hygiene and food preparation (Threshold) and 40 liters of water (Objective). In addition, 4 additional liters of water storage capacity per occupant shall be provided in separate containers (Threshold).

3.4.7.5 Water Storage Weight.

Each provision for storing and distributing water shall be man portable; weighing no more than 6 Lbs total when empty (Theshold). (Weight of empty Jerry can).

3.4.7.6 Water Storage Quality.

Provisions for storing water shall be sealable to prevent degradation of water quality when exposed to environmental operating conditions in section 3.2 (Threshold). Degradation in water quality is defined as non-compliance with TB-MED 577(2010) DOD 5 L/Day tri-service standard resulting from environmental exposure to the storage provision. HASS water storage provisions shall permit no exposure to BPA (Threshold). Storage provision construction material shall not leech into the contained water when exposed to ambient temperatures in the range specified in section 3.2 (Threshold).

3.4.7.7 Water Storage Distribution.

Water storage provisions shall be capable of dispensing water directly to users for consumption without the loss of any water (Threshold).

3.4.8 Communications.

HASS shall incorporate provisions for one-way (Receive) communication which has the ability to produce power for its operation organically (Threshold) and two-way communication (Objective).

3.4.9 Natural Lighting.

The HASS shall be capable of providing natural light to the internal volume (Threshold). The HASS shall have provisions to adjust the amount of natural light entering the HASS from 0% to 100%. Provisions for providing natural light shall be securable and closable (Objective). When secured and closed, provisions for natural lighting shall be opaque.

3.4.10 Artificial Lighting.

The HASS shall have provisions for artificial lighting (Objective).

3.4.10.1 Artificial Lighting Performance.

Artificial lighting provisions shall be capable of providing 500 LUX to all covered floor space in the HASS in accordance with MIL-STD-1472D: Table XV (Objective).

3.4.11 Occupant Privacy.

The HASS shall have provisions that allow dividing of internal volume for occupant privacy (Threshold). Dividing provisions shall be opaque.

3.4.11.1 Divider Volume Division.

Dividing provisions shall allow for the ¼ of the total HASS volume to be separated by internal divider while maintaining cross-ventilation.

Humanitarian Assistance Shelter System (HASS)

3.4.12 Ventilation Provisions.

The HASS shall have provisions for natural ventilation.

3.4.12.1 Ventilation Size.

Provisions for natural ventilation shall be achieved through an unobstructed aperture with a total area equivalent to 0.5 m^2.

3.4.12.2 Ventilation Performance.

The HASS shall enable interior air changes from 7 per hour to 14 per hour. Air changes should be defined using blower door at 50 Pa pressure difference. This may be calculated using the equation N = 60 Q / V where: N = number of air changes per hour; Q = volumetric flow rate of air in cubic metres per minute; and V = space volume in cubic meters in accordance with Transitional Shelter Standards Version 10B (2010).

3.4.12.3 Ventilation Securing Provisions.

Provisions for natural ventilations shall be capable of being closed and secured.

3.4.13 Scalability and Modularity.

The HASS shall connect to another of the same type to increase the covered area. It shall be possible to connect the shelters using only the components and tools provided with the HASS.

3.4.13.1 Scalability and Modularity Interface Size.

The HASS shall have an interface that allows adequate clearance for movement and to ingress/egress to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).

3.4.14 Human Factors.

The HASS shall be operable and maintainable by adults when considering the full range of anthropometric measurements in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).

3.4.14.1 Ingress/Egress.

The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and to perform all required tasks in an erect stance.

3.4.14.2 Emergency Egress Time.

The HASS shall allow users to exit the shelter when all doors are secured within 30 seconds in accordance with Transitional Shelter Standards Version 10B (2010).

3.4.14.3 Major Assembly Weight.

Each inseparable assembly of the HASS which must be moved into place for construction shall weigh no more than 74 Lbs. Each separable component of the HASS which must be lifted during the construction phase shall weigh no more than 74 Lbs.

3.4.15 Safety.

The HASS shall incorporate safety features/capabilities to protect occupants, maintainers and transportation handlers.

3.4.15.1 Operational Safety.

The HASS shall not allow components of the HASS to become dislodged in its operational configuration when exposed to vibration conditions as stated in Section 3.3.5 of this specification.

3.4.15.2 Operational Safety Hazards.

The HASS shall prevent tripping hazards. For example, doorways, aisles, and walkways will be free of tripping hazards such as thresholds, cords, hoses, steps and other projections.

3.4.15.3 Sharp Edges and Corners.

The HASS shall be free of sharp edges and pointed projections.

3.4.15.4 Moving Parts.

The HASS shall not have any exposed moving parts, which could injure personnel.

3.4.15.5 Storage and Transportation Safety.

The HASS shall prevent warehouse personnel and maintenance personnel from injury during its storage and transport. Forklift movements shall not cause any components of the HASS to become dislodged from its packaging.

3.4.15.6 Vector-Born Disease.

The HASS shall provide occupants protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g snakes, scorpions, rats, mosquitoes) in accordance with Oxfam Transitional Settlement Displaced Populations dated 2005. Any opening, seam, or gap in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with knitted polyester, plastic-coated or impregnated fiber-glass yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.

3.4.15.7 Unsafe Conditions during Maintenance.

Users shall be able to maintain the HASS without being exposed to unsafe conditions.

3.4.15.8 *Component Location Safety.*

The HASS shall identify and locate interior components so as to prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death.

3.4.15.9 *Toxic Gases.*

The HASS internal volume shall meet OSHA threshold limit values for all toxic gases IAW Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 dated 1998.

3.4.15.10 *Security.*

Any opening of the HASS which is large enough to accommodate a 5th percentile female in IAW the U.S. Army’s 1998 Anthropometric Survey shall be securable to impede unwanted entry (Objective).

Humanitarian Assistance Shelter System (HASS)

4 VERIFICATION

Verification shall be performed to determine that the HASS offered for acceptance conforms to the requirements contained in Section 3. Verification shall be conducted using the following methods: inspection, demonstration, analysis, testing, or any combination thereof.

4.0 Verification Inspections and Tests. This performance specification will require inspections and tests only as necessary to verify performance of the system. The manufacturer shall perform quality assurance inspections and provide appropriate certifications of design compliance. Types of verification include:

a. Inspection. Non-destructive visual, auditory, olfactory, tactile, simple physical manipulations, gauging and measurement inspections.
b. Analysis. Analytical verification by mathematical analysis, statistical analysis, and evaluation of the correlation of measured data and observed test results with calculated expected values and conformance of end items with the specification.
c. Demonstration. An un-instrumented test when success is determined on the basis of observation alone.
d. Test. Instrumented test verified by actual measurement that the equipment meets the requirements of the specification when subjected to the actual conditions (or simulated conditions) specified.
e. Certification. Formal confirmation of requirement certification(s) of those items shall be documented in accordance with contract requirements or instructions. Certifications do not release the design contractor of responsibility for compliance.

4.0.1 Classifications of Verification. The inspection requirements specified herein are classified as follows:

4.0.2 Contractor Factory Acceptance Verification (CFAV). The Contractor shall verify system performance and suitability through simulation or previous testing at the Contractor’s facility or facility of the Contractor’s choosing. Documentation shall be provided to the Government for certification. The factory acceptance shall be conducted utilizing a Government approved Final Inspection Record (FIR).

4.0.3 Government Verification (GV). The Government shall verify the system performance of the HASS during operational conditions at the Government’s testing facility. To determine conformance to Section 3, after completion of the FAC, the system shall be subjected to a Production Qualification Testing (PQT) at a Government test site in accordance with the requirements specified in Table 3.2.

D = Demonstration I = Inspection A = Analysis T = Test C = Certification

Humanitarian Assistance Shelter System (HASS)

Table 4.1 - Requirements/Verification Matrix

TITLE	REQUIREMENT SECTION	VERIFICATION SECTION	CFAV	GV
General	3.1	4.2.4	-	-
Environmental Operating Conditions	**3.2**		**-**	**-**
Temperature	3.2.1	4.3.1	C	T
Rain	3.2.2	4.3.3	C	T
Sand Conditions	3.2.3	4.3.4	C	T
Dust Conditions	3.2.4	4.3.5	C	T
Icing Conditions	3.2.5	4.3.6	C	T
Humidity	3.2.6	4.3.7	C	T
Fungus	3.2.7	4.2.7	C	-
Mold	3.2.8	4.2.8	C	-
Mildew	3.2.9	4.2.9	C	-
Wind	3.2.10	4.3.8	C	T
Snow	3.2.11	4.3.9	C	T
Salt Fog	3.2.12	4.3.10	C	T
Performance Requirements	3.3	-	-	-
Operational Lifecycle	3.3.1	4.3.1	-	T
Operating Terrain	3.3.2	4.3.2	-	T
Water-resistant	3.3.3	4.3.3	C	T
Reliability	3.3.4	4.3.4	A	T
Mean Active Maintenance Time (M).	3.3.4.1	4.3.4.1	-	T
Corrective Maintenance.	3.3.4.2	4.3.4.2	-	T
Mean Time Between Preventive Maintenance	3.3.4.3	4.3.4.3	-	T
Vibration	3.3.5	4.3.5	C	T
Altitude	3.3.6	4.3.6	A	A
Long Term Storage Needs	3.3.7	4.3.7	A	-
HASS Assembly	3.3.8	4.3.8	A	D
HASS Operation	3.3.9	4.3.9	A	D

Humanitarian Assistance Shelter System (HASS)

TITLE	REQUIREMENT	VERIFICATION	CFAV	GV
Design	**3.4**		**-**	**-**
Shelter Capability	3.4.1	4.4.1	A	D
Materials	3.4.2	4.4.2	A/C	A
Material Sources	3.4.2.1	4.4.2.1	A	I/D
COTS Material and Component Selection	3.4.2.2	4.4.2.2	-	I
Flammable Liquids and Materials	3.4.2.3	4.4.2.3	A	A
Toxicity of Materials	3.4.2.4		A	A
Treatment and Painting of Materials	3.4.2.5	4.5.13	A	A
Color	3.4.3	4.5.14	A	I
Labeling	3.4.4	4.5.15	-	I
Transport	3.4.5		-	D
Transportation Configuration	3.4.5.1		-	D
Forklift	3.4.5.1.1		-	D
Food Preparation and Storage	3.4.6		-	-
Food Storage Equipment	3.4.6.1		-	T
Food Storage Equipment Volume	3.4.6.1.1		-	T
Food Storage Equipment Quantity	3.4.6.1.2		-	T
Food Preparation and Distribution Kits	3.4.6.2		-	I
Food Preparation and Distribution Kit Material.	3.4.6.2.1		C	-
Food Preparation and Distribution Kit Type	3.4.6.2.2		-	D
Food Preparation	3.4.6.3		-	-
Food Preparation Equipment Heat Transfer Performance	3.4.6.3.1		-	T
Food Preparation Equipment Surface Area Performance	3.4.6.3.2		-	A/T
Food Preparation Equipment Cooking Surface Material	3.4.6.3.3		C	-
Food Preparation Equipment Efficiency	3.4.6.3.4		-	T
Water Purification, Storage, and	3.4.7		-	-

Humanitarian Assistance Shelter System (HASS)

TITLE	REQUIREMENT	VERIFICATION	CFAV	GV
Distribution				
Water Purification Temperature	3.4.7.1		-	T
Water Purification Rate	3.4.7.2		-	T
Water Purification Quality	3.4.7.3		-	T
Water Storage Volume	3.4.7.4		-	T
Water Storage Weight	3.4.7.5		-	T
Water Storage Quality	3.4.7.6		-	T
Water Storage Distribution	3.4.7.7		-	D
Communications	3.4.8		C	T
Natural Lighting	3.4.9		C	D
Artificial Lighting	3.4.10		C	T
Electrical Cables/Cords of Artificial Lighting	3.4.10.1		C	A
Occupant Privacy	3.4.11		C	I
Divider Volume Division	3.4.11.1		C	I
Ventilation Provisions	3.4.12		C	D
Ventilation Size	3.4.12.1		C	T
Ventilation Performance	3.4.12.2		C	T
Ventilation Securing Provisions	3.4.12.3		-	T
Scalability and Modularity	3.4.13		C	T
Scalability and Modularity Interface Size	3.4.13.1		C	T
Human Factors	**3.4.14**			
General	3.4.14.1	4.5.17.1	-	-
Ingress/Egress	3.4.14.2		A	T
Emergency Egress Time	3.4.14.3		A	T
Major Assembly Weight	3.4.14.4		A	T
Safety	**3.4.15**			
Operational Safety	3.4.15.1	4.5.19.1	C	T
Operational Safety Hazards	3.4.15.2	4.5.20	C	I
Sharp Edges and Corners	3.4.15.3		-	I

Humanitarian Assistance Shelter System (HASS)

TITLE	REQUIREMENT	VERIFICATION	CFAV	GV
Moving Parts	3.4.15.4		-	I
Storage and Transportation Safety	3.4.15.5	4.5.20.1	C	T
Vector-Born Disease	3.4.15.6	4.5.21	C	T
Unsafe Conditions during Maintenance	3.4.15.7	4.5.21.1	C	T
Component Location Safety	3.4.15.8	4.5.21.2	C	T
Toxic Gases	3.4.15.9		C	A
Security	3.4.15.10		C	D

4.1 General.

To determine conformance of Section 4.1, the contractor shall verify by analysis and certification that the performance, design, and environmental requirements for the HASS are met.

4.2 Environmental Operating Conditions

4.2.1 Temperature.

To determine conformance of 3.2.1, the Government shall verify by testing that components of the HASS are capable of operating in extreme ambient temperatures ranging from –22o F to 131o F (Threshold) and 144 o F (Objective) (–30o C to 55o C [Threshold] and 62.2o C [Objective]). A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.1. To determine conformance to Section 3.2.1, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 501.4, Procedure II and Method 502.4, Procedure II.

4.2.2 Rain.

To determine conformance of 3.2.2, the Government shall verify by testing that components of the HASS operate without degradation in non-accumulating rain conditions with rainfall rates up to 2.5 inches per hour (Threshold) and 4 inches per hour (Objective). A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.2. To determine conformance to Section 3, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 506.4, Procedure I.

4.2.3 Sand Conditions.

To determine conformance of 3.2.3, the Government shall verify by testing that the HASS operate without degradation in blowing sand conditions with sand concentrations up to 1.1 ± 0.3 grams per cubic meter (0.033 ± 0.0075 grams per cubic foot), particle size between 150 to 850 micrometers, and wind speeds up to 40 miles per hour. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.3. To determine conformance to Section 3.2.3, the HASS shall

be subjected to a government test in accordance with MIL-STD-810F, Method 510.4, Procedure II.

4.2.4 Dust Conditions.

To determine conformance of 3.2.4, the Government shall verify by testing that components of the HASS operate without degradation in blowing dust conditions with particle size less than or equal to 149 micrometers and wind speeds up to 20 miles per hour. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.4. To determine conformance to Section 3.4.4, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 510.4, Procedure I.

4.2.5 Icing Conditions.

To determine conformance of 3.2.5, the Government shall verify by testing that components of the HASS operate without degradation in freezing rain/ice conditions with glaze ice thickness up to 0.5 inch on horizontal surfaces. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.5. To determine conformance to Section 3.2.5, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 521.2.

4.2.6 Humidity.

To determine conformance of 3.2.6, the Government shall verify by testing that components of the HASS operate without degradation in humidity up to 100 percent RH. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.7. To determine conformance to Section 3.2.6, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 507.4, Procedure I Modified Aggravated Humidity Cycle Test.

4.2.7 Fungus.

To determine conformance of 3.2.7, the contractor shall verify by certification that the HASS experience only a Light (Threshold) and trace (Objective) amount of Fungus growth on the shelter as defined in MIL-STD-810G through its operational lifecycle (threshold value). A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.7.

4.2.8 Mold.

To determine conformance of 3.2.8, the contractor shall verify by certification that of the HASS shall be mold resistant consistent with best commercial practice. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.8.

4.2.9 Mildew.

To determine conformance of 3.2.9, the contractor shall verify by certification that the HASS shall be mildew resistant consistent with best commercial practice throughout the operational lifecycle of the HASS. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.9.

4.2.10 Wind.

To determine conformance of 3.2.10, the contractor shall verify by certification that the HASS is capable of operation and storage without degradation in high wind conditions with wind speeds up to 40 miles per hour (Threshold) and 100 miles per hour (Objective). A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.10. To determine conformance to Section 3.2.10, the HASS shall be subjected to a government test in which the vehicle will be tested and analyzed through a simulated wind load to determine conformance to 3.2.10.

4.2.11 Snow.

To determine conformance of 3.2.11, the contractor shall verify by certification that components of the HASS are capable of sustaining snow loads up to .0435 psi (Threshold) and .058 psi (Objective) without damage. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.11. To determine conformance to Section 3.2.11, the HASS shall be subjected to a government test in which the HASS will be tested and analyzed through a simulated snow load to determine conformance to 3.2.11.

4.2.12 Salt Fog.

To determine conformance of 3.2.12, the contractor shall verify by certification that the HASS is capable of operating and being stored in, without degradation, in an environment where there is a 5% ± 1% concentration of salt fog. A FIR shall be utilized to certify, by the contractor, of compliance to 3.2.12. To determine conformance to Section 3.2.12, the HASS shall be subjected to a government test in accordance with MIL-STD-810F, Method 509.4.

4.3.1 Operational Lifecycle.

To determine conformance of 3.3.1, the Government shall verify that the HASS system shall survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed using testing.

4.3.2 Operating Terrain.

To determine conformance with 3.3.2, the HASS shall be subjected to a government run test to demonstrate operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized (Objective). The system shall be able to operate on a surface with a 12” slope over the 20’ length (Threshold).

4.3.3 Water Resistance.

To determine conformance to 3.3.3, the HASS, without additional equipment or preparation, shall be tested for water resistance to preclude internal damage from the applicable environmental operating requirements contained in Section 3.2 of this specification. The contractor shall certify that components of the HASS are water resistant to a depth of 20ft utilizing a FIR.

4.3.4 Reliability.

To determine conformance to 3.3.4.1, the contractor shall verify by analysis that the HASS has a 95% (T) and 99% (O) reliability over the intended lifecycle (2.5 years) with a lower bound 90% confidence interval. The HASS shall be subjected to a government run test to demonstrate reliability.

4.3.4.1 Corrective Maintenance.

To determine conformance to 3.3.4.4, the HASS shall be tested by the Government to demonstrate that all corrective maintenance shall be performed utilizing supplied general purpose tools. During Government testing, the HASS shall be tested to ensure no specialized tools for repairs are required. All tools required to make repairs shall be COTS. Tools necessary to perform the required repair tasks shall require no specialized training. Any repairs shall be performed by an untrained adult. Materials necessary for repair shall be included in the HASS.

4.3.4.2 Mean Time Between Preventive Maintenance.

To determine conformance to 3.3.4.5, the Government shall verify by testing that components of the HASS have a mean time between maintenance (MTBM) of 615 hours of normal operation between scheduled preventative maintenance services unless said preventive maintenance involves routine cleaning; in which case preventive maintenance intervals will be prescribed by the component's manufacturer or by the Government.

4.3.4.3 Mean Active Maintenance Time (M).

To determine conformance to 3.3.4.6, the HASS shall be tested by the Government to determine that a Mean Active Maintenance Time of 7 hours during its operational lifecycle of 21,914 hours (2.5 years) is achieved.

4.3.5 Vibration.

To determine conformance to 3.3.5, the Government shall verify by testing that the HASS operate at normal capacity without degradation during and after exposure to the following vibration profile in accordance with MIL-STD-810 G section 514.6. A FIR shall be utilized by the contractor to determine conformance to 4.3.5. The following tests are to be conducted to determine conformance:

1) Trucks & trailers-Test I
2) Aircraft (Jet, Prop, Helo)-Test I
3) Watercraft-Test 1
4) Railroad-Test 1"

RMS Acceleration:1 (Grms):
Vertical - 1.04;
Transverse - 0.20;
Longitudinal - 0.74.

Velocity (in/sec) (peak single amplitude):1

Vertical – 7.61;
Transverse – 1.21;
Longitudinal – 4.59.

Displacement (in) (peak double amplitude):1
Vertical – 0.20
Transverse – 0.02;
Longitudinal – 0.11.

4.3.6 Altitude.

To determine conformance to 3.3.6, the Contractor shall verify through analysis that the HASS shall be capable of transport without degradation at altitudes from 0 to 35,000 feet above sea level. Contractor shall verify through analysis that the system can operate from 0 to 10,000 feet above sea level.

4.3.7 Long Term Storage Needs.

To determine conformance to 3.3.7, the Contractor shall verify through analysis that the HASS be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Applicable packaging of the HASS shall be provisioned for 10 years of storage. A FIR shall be utilized to certify, by the contractor, of compliance to 3.3.7.

4.3.8 HASS Assembly.

To determine conformance to 3.3.8, the contractor shall validate through analysis that the HASS is capable of being assembled by untrained adults with the supplied non-specialized general purpose tools which are COTS and require no specialized training to use. To determine conformance to 3.3.8, the HASS will be subjected to a government verification demonstration whereby the HASS will be assembled by untrained adults using the general purpose tools supplied with the HASS.

4.3.9 HASS Operation.

To determine conformance to 3.3.9, the contractor shall validate through analysis that the HASS is capable of being operated using no specialized skills or training. To determine conformance to 3.3.9, the HASS will be subjected to a government verification demonstration whereby the HASS will be operated by untrained occupants possessing no specialized skills or training relevant to the HASS.

4.4 Design

4.4.1 Shelter Capability.

To determine conformance to Section 3.4.1, the contractor shall verify through analysis that the HASS provides 3.5m^2 of covered floor space per occupant for 5 occupants (Threshold) and 4.5m^2 of covered floor space per occupant for 10 occupants (Objective). To determine

conformance to Section 3.4.1 the HASS will be subjected to a government test whereby the occupancy capacity of the HASS will be demonstrated.

4.4.2 Materials.

To determine conformance to Section 3.4.2, the contractor shall verify through analysis that the components used in the construction of the HASS do not contain any hazardous material as identified in the WHMIS, has no ozone depleting substances, and utilize ozone resistant consistent with best commercial practice. To determine conformance to Section 3.4.2 the HASS shall be independently analyzed by the government that the HASS does not contain any hazardous material as identified in the WHMIS, has no ozone depleting substances, and utilize ozone resistant consistent with best commercial practice.

4.4.2.1 HASS Modification.

To determine conformance to Section 3.4.2.1, the contractor shall verify through analysis that the construction of the HASS can leverage recycled, recovered, locally available, or environmentally preferable materials. To determine conformance to Section 3.4.2.1 the HASS will be subjected to a government test and inspection to ensure that the construction of the HASS can leverage recycled, recovered, locally available, or environmentally preferable materials.

4.4.2.2 COTS Material and Component Selection.

To determine conformance with 3.4.2.2, the components of the HASS shall be listed individually with an indication whether or not each component is COTS. Analysis shall determine what percentage by number of items is COTS.

4.4.2.3 Flammable Liquids and Materials.

To determine conformance with 3.4.2.3, each liquid or material used in the HASS shall be checked against OSHA 1926.152 Class 1A, 1B, and 1C. Vendor certification that materials meet OSHA 1926.152 shall suffice.

4.4.2.4 Toxicity of Materials.

To determine conformance with 3.4.2.4, the assembled HASS shall be analyzed for sources of skin irritation or other injuries, and for noxious odors. Vendor's certification of non-toxicity shall suffice. Government shall analyze through independent laboratories of compliance to 3.4.2.4.

4.4.2.5 Treatment and Painting of Materials.

To determine conformance of 3.4.2.5, the government shall verify by analysis that components of the HASS which are rated as Class II, or III IAW OSHA 1926.152 flammability and combustibility classification system are treated accordingly in order conduct ASTM D6413-94 with a resulting char length of no more than 7 inches.

Humanitarian Assistance Shelter System (HASS)

4.4.3 Color.

To determine conformance of 3.4.3, the contractor shall verify by analysis, and the government shall verify by inspection, that the components and materials of the HASS are white, Number FS 37925, in accordance FED-STD-595(1994); unless exceptions were made for cultural and political sensitivities.

4.4.4 Labeling.

To determine conformance of 3.4.4, the government shall verify by inspection that the components and materials of the HASS are labeled permanently are molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive in accordance with MIL-STD-130M, Section 3.1-3.3.

4.4.5 Transport.

To determine conformance of 3.4.5, the government shall:

a. verify by demonstration that (in transport configuration) the HASS is capable of fitting through a standard 8'x8'x20' ISO container;
b. verify by demonstration that (in transport configuration) the HASS is capable of being tied down in a standard 8'x 8'x 20' ISO container utilizing an E-Track system with ratchet straps (http://www.usacargocontrol.com), without causing any damage to the HASS or its components;
c. verify by demonstration that (in transport configuration) the HASS is capable of surviving the vibration requirements in section 3.3.9 without any damage or degradation of performance

4.4.5.1 Transportation Configuration.

To determine conformance of 3.4.5.1, the government shall verify by demonstration that (in transport configuration):
a. Four (4) HASSs are capable of fitting on one (1) standard pallet (Objective); and
b. One (1) HASS is capable of fitting on three (3) standard pallets (Threshold).
Standard pallet size is defined as 48" x 45" with standard forklift pocket dimensions IAW ISO Standard 1496-1 (1990).

4.4.5.1.1 Forklift.
To determine conformance of 3.4.5.1.1, the contractor shall verify by demonstration that the HASS (in transport configuration) is capable of being lifted into and out of standard shipping containers by a forklift without damage.

4.4.6 Food Preparation, Storage and Distribution.

4.4.6.1 Food Storage Equipment.

To determine conformance of 3.4.6.1, the government shall verify by testing that the Food Storage Equipment components of the HASS are water proof and air tight. To determine

conformance to Section 3.4.6.1, the HASS shall be subjected to a government test in which the Food Storage Equipment will be tested in respect to its ability to shield its contents from external sources of water and air.

4.4.6.1.1 Food Storage Equipment Volume.
To determine conformance of 3.4.6.1.1, the government shall verify by testing that each individual piece of Food Storage Equipment is capable of containing 6 qt of water.

4.4.6.1.2 Food Storage Equipment Quantity.
To determine conformance of 3.4.6.1.2, the government shall verify by inspection that 4 specified Food Storage Equipment components are present in the HASS.

4.4.6.2 Food Preparation and Distribution Kits.

To determine conformance of 3.4.6.2, the government shall verify by inspection that the HASS is inclusive of each specified food distribution component in the quantities required.

4.4.6.2.1 Food Preparation and Distribution Kit Material.
To determine conformance of 3.4.6.2.1, the contractor shall verify by certification that the Food Preparation and Distribution Kit is made out of Stainless Steel. A formal material spec sheet from the supplier certifying the Food Preparation and Distribution Kit components as being made out of Stainless Steel is acceptable.

4.4.6.3 Food Preparation.

To determine conformance of 3.4.6.3, the government shall verify by test that the provided food preparation equipment is capable on its own, or with the aid of the food distribution kit of boiling, braising, pan-frying, and griddling. To determine conformance to Section 3.4.6.3, the Food Preparation equipment will be subjected to a government test.

4.4.6.3.1 Food Preparation Equipment Heat Transfer Performance.
To determine conformance of 3.4.6.3.1, the government shall verify by Test that the Food Preparation equipment is capable of boiling water from an initial temperature of 70°F to a final temperature of 212F in 30 minutes or less with an ambient temperature of 32°F. To determine conformance to Section 3.4.6.3.1, the Food Preparation equipment will be subjected to a government test.

4.4.6.3.2 Food Preparation Equipment Surface Area Performance.
To determine conformance of 3.4.6.3.2, the government shall verify by Test and analysis that the food preparation equipment is capable of bringing an unloaded cooking surface (for braising, pan frying, and griddling) to a temperature of 375°F or greater in ambient temperatures equal to or greater than 32°F from an initial surface temperature equal to the ambient temperature in a maximum of 15 minutes. Food preparation equipment shall be able to perform ASTM Test F 1275-03(2008) section 10.7 (Cooking energy efficiency and production capacity) and have a result of a cook time of 10 minutes or less per load with a maximum recover time of 5 minutes.

4.4.6.3.3 Food Preparation Equipment Cooking Surface Material.
To determine conformance of 3.4.6.3.3, the contractor shall verify by certification that the Food Preparation Equipment Cooking Surface is made out of a corrosion resistant material. A formal material spec sheet from the supplier certifying the Food Preparation Equipment Cooking Surface is made out of a corrosion resistant material is acceptable. To determine conformance to Section 3.4.6.3.3, the Food Preparation Equipment and its supplied spec sheet shall be subjected to a government examination.

4.4.6.3.4 Food Preparation Equipment Efficiency.
To determine conformance of 3.4.6.3.4, the government shall verify by Test that the food preparation equipment's net efficiency is no less than 40%.

4.4.7 Water Purification, Storage, and Distribution

4.4.7.1 Water Purification Temperature.

To determine conformance of 3.4.7.1, the government shall verify by testing that the components of the HASS are capable of purifying indigenous fresh water sources at temperatures between 32F and 170F.

4.4.7.2 Water Purification Rate.

To determine conformance of 3.4.7.2, the government shall verify by testing that components of the HASS operate without degradation in purifying indigenous fresh water sources at a rate of 5 L/Day per user. A FIR shall be utilized to certify, by the contractor, of compliance to 3.4.7.2.

4.4.7.3 Water Purification Quality.

To determine conformance of 3.4.7.3, the contractor shall verify by testing that the HASS operate without degradation in purifying indigenous fresh water sources IAW NSF P231 and TB-MED 577 (2010) to meet DOD 5 L/Day tri-service water quality standards for the duration of the operational cycle (Objective). To determine conformance to Section 3.4.7.3, the HASS shall be subjected to a government test in accordance with TB-MED 577 sections 5-4 and 5-5 and NSF P231.

4.4.7.4 Water Storage Volume.

To determine conformance of 3.4.7.4, the government shall verify by testing that the HASS have capacity to store 20 liters of water for consumption, personal hygiene and food preparation (Threshold) and 40 liters of water (Objective). In addition, 4 additional liters of water storage capacity per occupant shall be provided in separate containers. To determine conformance to Section 3.4.7.4 the HASS shall be subjected to a government test that measures the storage volume of the containers to determine and verify the actual capacity to store 20 liters of water for consumption, personal hygiene and food preparation (Threshold) and 40 liters of water (Objective), as well as, 4 additional liters of water storage capacity per occupant provided in separate containers.

Humanitarian Assistance Shelter System (HASS)

4.4.7.5 Water Storage Weight.

To determine conformance of 3.4.7.5, the Government shall verify by testing that the HASS weigh no more than 6 Lbs total when empty. To determine conformance to Section 3.4.7.5 the HASS shall be subjected to a government test that measures the weight of the containers when empty to verify that they weigh no more than 6 Lbs when empty.

4.4.7.6 Water Storage Quality.

To determine conformance of 3.4.7.6, the Government shall verify by testing that the HASS comply with TB-MED-577. To determine conformance to Section 3.4.7.6 the HASS shall be subjected to a government test IAW TB-MED-577 and conformance of Appendix B DoD Tri Service Standards for field drinking water.

4.4.7.7 Water Storage Distribution.

To determine conformance of 3.4.7.7, the Government shall verify by demonstration that components of the HASS are capable of dispensing water directly to users for consumption without the loss of any water in approved storage containers in 3.4.7.4. To determine conformance to Section 3.4.7.7 the HASS shall be subjected to a government test that dispenses water from storage containers to ensure that there is no loss of water between transfers.

4.4.8 Communications.

To determine conformance of 3.4.8, the contractor shall verify by certification that components of the HASS have provisions for one-way communication which has the ability to produce power for its operation organically (Threshold) and two-way communication (Objective). To determine conformance to Section 3.4.8, the HASS shall be subjected to a government test.

4.4.9 Natural Lighting.

To determine conformance of 3.4.9, the contractor shall verify by certification that the HASS is capable of naturally illuminating the internal volume. To determine conformance to Section 3.4.8, the HASS shall demonstrate conformance to 3.4.9.

4.4.10 Artificial Lighting.

To determine conformance of 3.4.10, the contractor shall verify by certification that the HASS has provisions for artificial lighting. To determine conformance to Section 3.4.10, the HASS shall be subjected to a government test to verify conformance to 3.4.10.

4.4.10.1 Artificial Lighting Performance.

To determine conformance with 3.4.10.1, the HASS shall be subjected to a government run test to demonstrate artificial lighting provisions can produce 500 LUX of illuminance. The contractor shall certify by utilizing a FIR to ensure conformance to 3.4.10.1.

4.4.11 Occupant Privacy.

To determine conformance to 3.4.11, the contractor shall verify through certification utilizing a FIR that the HASS has a500 Lux light source (Reference 3.4.10.1) within the HASS, that no silhouette of an occupant is visible on either side of the divider. A FIR shall be utilized to certify, by the contractor, of compliance to 3.4.11. To determine conformance to Section 3.3.11, the HASS shall be subjected to a government inspection in which the HASS will be inspected for a 500 LUX light source to determine conformance to 3.4.11.

4.4.11.1 Divider Volume Division.

To determine conformance of 3.4.11.1, the contractor shall verify by certification that the HASS system has dividing provisions that allow for the ¼ of the total HASS volume to be separated by internal divider while maintaining cross-ventilation (Reference 4.4.12.2 for ventilation performance verification). An inspection shall be performed by the government to ensure compliance to 3.4.11.1.

4.4.12 Ventilation Provisions.

To determine conformance of 4.4.12, the contractor shall verify by certification that the HASS system meets the verification as described in 4.4.12.1, 4.4.12.2, and 4.4.12.3. To determine conformance to Section 3.4.12, the HASS shall be subjected to a government demonstration.

4.4.12.1 Ventilation Size.

To determine conformance of 3.4.12.1, the contractor shall certify that the HASS system has an unobstructed aperture with a total area equivalent to .5m^2 using examination to include appropriate gauges and measuring instruments.

4.4.12.2 Ventilation Performance.

To determine conformance of 3.4.12.2, the contractor shall verify by certification that the HASS system is capable of achieving 7 to 14 air changes per hour. Analysis and calculations shall be consistent with Transitional Shelter Standards Version 10B (2010) Section IV, Reference XIII. Testing shall be performed with the internal divider (reference 3.4.11.1) installed by the government. A FIR shall be utilized to certify, by the contractor, of compliance to 3.4.12.2

4.4.12.3 Ventilation Securing Provisions.

To determine conformance of 3.4.12.3, the government shall verify by test that the HASS has provisions for closing and securing natural ventilation provisions.

4.4.13 Scalability and Modularity.

To determine conformance of 3.4.13, the contractor shall verify certification that the HASS is capable of connecting to an identical HASS using only the components and tools provided with a single HASS. To ensure compliance with 3.4.13, the HASS shall be subjected to a government run test to ensure that HASS is capable of connecting to an identical HASS.

4.4.13.1 *Scalability and Modularity Interface Size.*

To determine conformance of 3.4.13.1, the contractor shall verify certification that the HASS interface allows for adequate movement to ingress/egress to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male). To ensure compliance with 3.4.13.1, the HASS shall be subjected to a government run test to ensure HASS interface allows for adequate movement to ingress/egress to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).

4.4.14 Human Factors.

4.4.14.1 *Ingress/Egress.*

To determine conformance with 3.4.14.1, the HASS shall be evaluated to ensure conformance of all structural components for clearance as described in section 5.6.3.1.2 of MIL-STD-1472 using analysis. The government shall verify by test that all openings and the doorway allow for un-impeded movement of an erect 95th percentile male with an additional 3 inches of vertical clearance and 6 inches of horizontal clearance.

4.4.14.2 *Emergency Egress Time.*

To determine conformance with 3.4.14.2, the contractor shall verify through analysis that occupant can egress the shelter when all doors are secured within 30 seconds. The HASS be subjected to a government test with doors closed and secured. The egress shall be timed beginning from a reclined position at the furthest point in the shelter from the door. All components of the shelter shall be inside the shelter when the egress is timed during government testing.

4.4.14.3 *Major Assembly Weight.*

To determine conformance with 3.4.14.3, the contractor shall verify using analysis that each component of the HASS weigh no more than 74lbs. To ensure compliance with 3.4.14.4, the government shall conduct a test where components shall be weighed to determine compliance with 3.4.14.4.

4.4.15 Safety.

4.4.15.1 *Operational Safety.*

To determine conformance of 3.4.15.1, the contractor shall verify by certification that the HASS shall not allow components of the HASS to become dislodged in its operational configuration when exposed to vibration conditions as stated in Section 3.3.5 of this specification. A FIR shall be utilized to certify, by the contractor, of compliance to 3.4.15.1. To determine conformance to Section 3.4.15.1, the HASS shall be subjected to a government test in which the vehicle will be tested to ensure HASS not allow components of the HASS to become dislodged in its operational configuration when exposed to vibration conditions as stated in Section 3.3.5 of this specification.

4.4.15.2 *Operational Safety Hazards.*

To determine conformance of 3.4.15.2, the contractor shall verify by certification that the HASS prevents tripping hazards and doorways, aisles, and walkways shall be free of tripping hazards such as thresholds, cords, hoses, steps and other projections. To ensure compliance with 3.4.15.2, the HASS shall be inspected by the government to ensure HASS prevent tripping hazards.

4.4.15.3 *Sharp Edges and Corners.*

To determine conformance to 3.4.15.3, the government shall inspect the HASS for sharp edges and projections.

4.4.15.4 *Moving Parts.*

To determine conformance to 3.4.15.4, the government shall inspect the HASS for any exposed moving parts, which could injure personnel.

4.4.15.5 *Storage and Transportation Safety.*

To ensure conformance to 3.4.15.5, the contractor shall certify that the HASS design shall prevent warehouse personnel and maintenance personnel from injury during its storage and that forklift movements shall not cause any components of the HASS to become dislodged from its packaging. The HASS shall be subjected to a government run test to make sure the HASS prevents warehouse personnel and maintenance personnel from injury during its storage. The contractor shall certify using a FIR to ensure compliance to 3.4.15.5.

4.4.15.6 *Vector-Born Disease.*

To ensure compliance with 3.4.15.6, the contractor shall certify that the HASS provides occupant protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g snakes, scorpions, rats, mosquitoes) in accordance with Oxfam Transitional Settlement Displaced Populations dated 2005. Any opening, seam, or gap in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with knitted polyester, plastic-coated or impregnated fiber-glass yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch. The HASS shall be subjected to a government run test to ensure compliance with 3.4.15.6 by measuring the size of the mesh and to ensure compliance with Oxfam Transitional Settlement Displaced Populations dated 2005.

4.4.15.7 *Unsafe Conditions during Maintenance.*

To ensure compliance with 3.4.15.7, the contractor shall certify that the HASS provides users shall be able to maintain the HASS without being exposed to unsafe conditions. The HASS shall be subjected to a government run test to ensure compliance with 3.4.15.7.

4.4.15.8 *Component Location Safety.*

To ensure compliance with 3.4.15.8, the contractor shall certify that the HASS locate interior components so as to prevent injury to users in case of an emergency. The HASS shall be

subjected to a government run test to ensure compliance with 3.4.15.8 by looking at the location of items.

4.4.15.9 *Toxic Gases.*

To determine conformance of 3.4.15.9, the contractor shall verify by certification that the HASS internal volume meets OSHA threshold limit values for all toxic gases IAW Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 dated 1998. The HASS shall be analyzed by the government to that the HASS internal volume meets OSHA threshold limit values for all toxic gases IAW Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 dated 1998.

4.4.15.10 *Security.*

To determine conformance of 3.4.15.10, the contractor shall verify by certification that the any opening of the HASS which is large enough to accommodate a 5th percentile female is in IAW the U.S. Army's 1998 Anthropometric Survey shall be securable as to stop unwanted entry. The HASS shall be subjected to a government run demonstration to ensure compliance with 3.4.15.10.

APPENDIX E: LOGISTICS AND MAINTENANCE CONCEPT

SE311-101O Capstone Project

Shelter Options for Humanitarian Assistance

Maintenance and Support Concept

Version 5.0

08/3/2011

Advisors

Dr. David Olwell – Brigitte Kwinn

Team Leader

Ben Williams

RECORD OF CHANGES

*A - ADDED M - MODIFIED D – DELETED

VERSION NUMBER	DATE	NUMBER OF FIGURE, TABLE OR PARAGRAPH	**A* M D**	TITLE OR BRIEF DESCRIPTION	CHANGE REQUEST NUMBER
1.0	03/12/11		A	Initial draft	
2.0	4/13/11		M	Modifications based on stakeholder input	
3.0	4/24/11		M		
4.0	7/24/11		M	Modified to align with System Spec	
5.0	8/3/2011	Section 1 & 3	M	Modified to align with System SPEC	BW

Table of Contents

List of Tables

List of Figures

This document briefly describes the maintenance and support concepts for the Humanitarian Assistance Shelter System (HASS). The HASS will be designed to require minimum user maintenance; however, corrective maintenance may be required.

1. Levels of Maintenance

The HASS will have two maintenance levels: (1) User maintenance; and (2) Warehouse maintenance. User maintenance will be performed by the users/disaster victims using tools provided by the along with the system. Warehouse maintenance will be performed by trained personnel with commercial-off-the-shelf (COTS) tools. Table 1 provides additional information on the type, location, performing agency, etc., for all anticipated maintenance.

Table 1 Maintenance Requirements

Criteria	**User Maintenance**	**Warehouse Maintenance**
Done where?	At disaster site	Warehouse
Done by whom?	Users (low maintenance skills)	Warehouse facility personnel or manufacturer's production personnel
What equipment?	Basic tools	COTS tools
Type of work accomplished?	Corrective Maintenance • Minor repairs Preventive Maintenance • Visual inspection • External adjustments	Preventive Maintenance • Detailed inspection and system checkout • Scheduled safety inspections

2. Maintenance Policies

Warehouse maintenance is the maintenance performed at the warehouse. This support provides inspection of stored units during storage for safety and operational readiness.

User maintenance is the maintenance performed on a deployed HASS system in the user environment. This support entails maintenance to ensure continued operation and usability of the HASS system once fielded.

In order to effectively maintain the physical condition of the shelters, it is necessary to set certain priorities so that more urgent requirements can take precedence over routine maintenance. Maintenance work shall be performed accordingly to the, following priorities:

a. Emergency – Life threatening, or extreme property damage.
b. Urgent – Major inconvenience to resident, property damage.
c. Routine – In accordance with shelter manufacturer's manual
d. Planned Maintenance – Planned and seasonal maintenance.

3. Repair Policies

The HASS system is a one-time deployable system and minor repairs may be performed in the field. However once the system has been deployed the failure of a major component, defined as a component in which a failure leads to the shelter being inhabitable, will lead to the disposal of that particular HASS. All maintenance actions will be performed by untrained adult using only basic tools provided with the HASS. Figures 1 summarizes the repair policies.

No Warehouse level maintenance will occur once a HASS system is deployed.

Repair Policies

User Maintenance	Warehouse Maintenance
• Unscheduled Maintenance • Replacement of non-structural components • Replace complete unit in case of structural damage	• Scheduled Maintenance • Inspect sample of units at predefined intervals • Replace units older than specified shelf life
• Scheduled Maintenance • Visual inspections • Minor Adjustments	• Support Factors • Support equipment—no external equipment • Personnel skill level—advanced
• Support Factors • Support equipment—no external equipment • Personnel skill level—basic • MTBM—697 hours	

Figure 1 Repair Policies

4. User Responsibilities

While the HASS system is located in the warehouse it will be maintained by the warehouse personnel. Once the HASS system has been deployed maintenance will be the responsibility of the users.

5. Maintenance Support Elements

The maintenance support elements are listed in Table 2.

Table 2 Maintenance Support Elements

Elements	**User Maintenance**	**Warehouse Maintenance**
Supply Support	Shelter kit	Supplies
Test and Support Equipment	Basic tools	Warehouse shop tools
Personnel and training	Occupants	Warehouse personnel

Elements	User Maintenance	Warehouse Maintenance
Transportation and handling equipment	None	Forklift, ladder
Facilities	Shelter itself	Warehouse shop
Data	Build instructions	Manual, procedure

6. Environment

On-site/User maintenance will be performed in the same environment as required for User use. Warehouse maintenance will be performed in the depot facilities or at the warehouse.

7. Spares Policy

Operational spares will be required to support the HASS system in the user environment. Operational spares are those spares that must be acquired to support on-going use of the HASS system.

The quantity and type of spares required to support continual use of the system should be determined according to the following:

- Items that are critical to system operation but can be replaced by the user
- Items that have a limited shelf life

The initial provisioning period should be able to support early operations to allow for sufficient time for a HA/DR support network to be set up and supported by an external organization.

APPENDIX F: CONFIGURATION MANAGEMENT PLAN

Naval Postgraduate School
SE311-1010 Capstone Project
09 Sept 2011

Configuration Management Plan
HASS-CMP-001
for

Humanitarian Assistance Shelter System

July 1, 2011

Revisions

Version	Description of Version	Date Completed
0.1	Initial draft	7/01/11

Review & Approval

Project Plan Review History

Reviewer	Version Reviewed	Approval Date

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Purpose

The purpose of this Configuration Management (CM) Plan is to provide an overview of the organization, activities, overall tasks, and objectives of the Humanitarian Assistance Shelter System (HASS) program. It addresses configuration item (CI) identification, change control and configuration audits at a high level. Additional details regarding CM activities, techniques, and tools are provided in the CM-related procedures (see HASS Document Repository for the most current procedures). These procedures are listed in Section 1.3, and referenced where applicable in this document.

1.2 Scope

The HASS project has established several levels of baseline, with appropriate levels of control for each, as summarized in Table 1.

Table 1 Baseline Control Authority

Baseline	Contents	Control Level
Requirements	System Specification	STAKEHOLDERS
Process	Documented processes, plans, and procedures	Systems Engineering Team – Program Management Office (SET-PMO)
Test	Analysis Testing Conceptual Design Testing Integration Testing	System Test Manager
Development	Local development environment	PMO

This document describes the CM approach for management of the requirements, and conceptual design development which are controlled at the HASS project level. The management and control of the test baseline is described in the System Integration and Test Plan. The conceptual design and development environments are managed and controlled at the local level. The Configuration Management Office (CMO) of the HASS program office maintains the HASS developmental baselines (design, integration, and preliminary system test) for each release in the HASS CM repository.

Changes to the requirements and developmental baselines are controlled by the HASS Configuration Control Board (CCB) (described in Section 2) via Configuration Change Requests (CCRs), Problem Reports (PRs), and Work Requests (WRs). Section 3 describes the CIs defined in these baselines and the process for managing changes to the CIs.

The design baseline is controlled by the PMO. Changes to CIs in this baseline are implemented via WRs, as described in the HASS Process Baseline Management Procedure. Section 4 of this document describes HASS document and data management.

1.3 Applicable Documents

The documents listed in Table 2 are stored in the HASS Document Repository residing with the HASS Program Management Office.

Table 2 List of Applicable Documents

Document Number	Title
Requirements Baseline	
HASS-SPEC-001	System Specification
HASS Process Baseline Plans	
HASS-PMP-001	Project Management Plan
HASS-CMP-001	Configuration Management Plan
HASS-SEP-001	Systems Engineering Plan
HASS CM Procedures	
HASS-1000-PRO-DOCMT	Document Management Procedure
HASS-1024-PRO-CM	Configuration Item Identification
HASS-1025-PRO-CM	Configuration Audits
HASS-1026-PRO-CM	Configuration Change Request
HASS-1027-PRO-CM	Database Configuration Management
HASS-1029-PRO-CM	Requirements Baseline Management
HASS-1034-PRO-CM	Issues and Action Tracking
HASS-1038-PRO-CM	Conceptual Design Change
HASS-1040-PRO-CM	Developmental Baseline Management
HASS-1048-PRO-CM	System Administration Change
HASS-1056-PRO-CM	Work Requests
HASS-1064-PRO-CM	Problem Reports
CM-Related Procedures	
HASS-1018-PRO-QM	Peer Reviews
HASS-1049-PRO-SIT	Operational Readiness Review

The HASS Document Control Numbers are maintained in the HASS requirements repository, and a full list identifying the version and location of the current baseline documents is posted in HASS Document Repository.

1.4 Acronyms

CCB	Configuration Control Board
CCR	Configuration Change Request
CI	Configuration Item
CM	Configuration Management
CMDB	Configuration Management Database

CMO	Configuration Management Office
CVS	Concurrent Versions System
HASS	Humanitarian Assistance Shelter System
HOT	HASS Operations Team
HPMT	HASS Project Management Team
ORR	Operational Readiness Review
PM	Program Manager
PMO	Program Management Office
PR	Problem Report
QMO	Quality Management Office
SAT	System Administration Team
SET	Systems Engineering Team
SIT	System Integration and Test
TAL	Technical Area Lead
TBD	To Be Determined
TBW	To Be Written
WR	Work Request

1.5 Definitions

Baseline	A formal, approved document or product serving as a departure point for future releases. The HASS baselines are described in Section 1.2 above.
CCR	A request for a change to a baseline document or system. A CCR is submitted by a stakeholder or team member.
CCB	The board defining the disposition of CCRs. The board is composed of PMO members, SET members, and the CMO.
CI	An aggregation of hardware, software, or both, designated for CM and treated as a single entity in the CM process.
Originator	The person who submits a CCR.
Oversight Group	A board consisting of representatives from STAKEHOLDERS, who provide vision and overall direction for the HASS project.
PR	A request for a change submitted to the HASS configuration management tool, documenting a problem identified during system integration and test.

Project Management Team	The managing authority for the HASS project. This team is defined in Section 2.
Stakeholders	Naval Postgraduate School Faculty (Dr. Olwell, Prof. Kwinn) & SPACOM /PACFLT/NAVFAC USAID)
SET	The technical advisory committee for HASS. This team is defined in Section 2.
WR	A request for a changed submitted to the HASS configuration management tool, documenting an activity that may be approved by the HASS Technical Area Lead (TAL).

2 Organization

In the last ten years, a number of large natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, and shelter have been lost and become critical needs for survival. The United States (US) Government is often a first responder in these events.

In order to support possible future US Government and Non-Governmental Organizations (NGO) humanitarian missions, a transitional shelter is needed. A capability gap exists in humanitarian shelters as there is not a universally accepted system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years). To serve the needs of displaced victims of disaster, the HASS must deploy and protect its occupants and serve their basic needs. Deployment includes set-up by untrained users with the assistance of locally-operating NGOs. The shelter may be connected to other shelters in order to accommodate larger families or other flexible uses.

This control is provided by the CMO, described in Section 2.1, under the direction of the CCB, described in Section 2.2.

2.1 Configuration Management Office

The CMO includes the personnel responsible for management of all components of the HASS baselines: design, hardware, and documentation. The CMO manages changes to the HASS requirements and developmental baselines with the review and approval of the HASS CCB.

The CMO includes the following roles:

- Requirements Manager – responsible for maintenance and update of the HASS requirements repository
- Document Manager – responsible for tracking project documentation
- System Administrator – responsible for tracking and maintenance of hardware components

2.2 Configuration Control Board

The HASS Project Management Team is responsible for overall direction and coordination for HASS. The Technical Area Lead (TAL) from each participating organization serves on the team. The SET HASS Technical Lead has authority for technical decisions related to HASS, while the HASS Program Manager (PM) maintains requirements baseline direction, administrative and budget authority.

Similarly, each development team is represented on the SET. The SET oversees the technical direction of the development to ensure consistency and compatibility among the various components. The HASS System Engineer and the HASS Lead Integrator are members of the SET.

The HASS CCB includes members of the PMO, the SET, and the stakeholders. Figure 1 shows the organizations participating in HASS development and represented on the CCB. This board reviews all HASS CCRs. The HASS Technical Lead chairs the CCB, and has decision-making authority on the disposition of CCRs, with input from the other CCB members. The Configuration Change Request Procedure provides a detailed description of the CCR process.

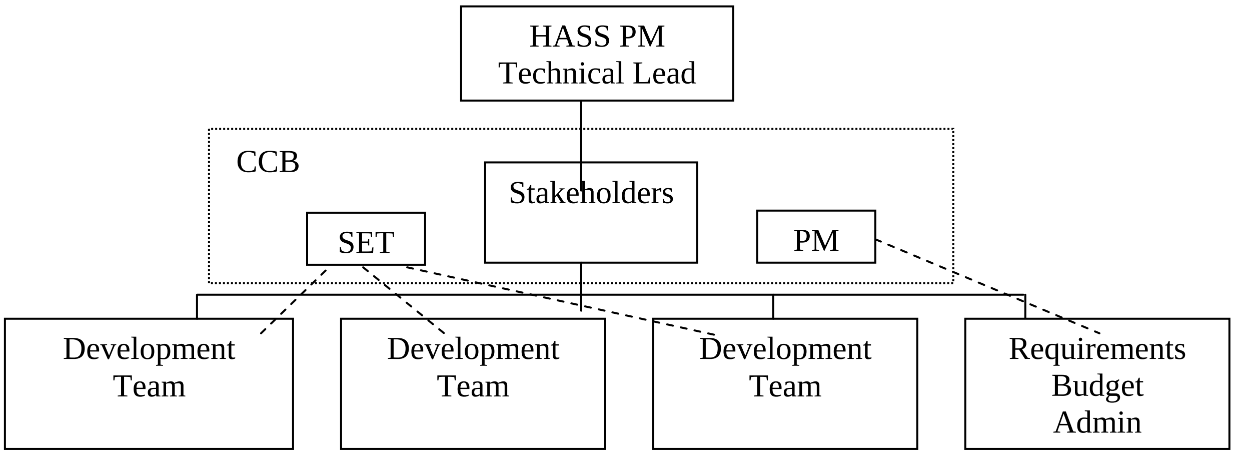


Figure 1 - HASS Organization

2.3 Tools

The following tools are used to manage the HASS baselines:

- HASS requirements repository – controlled repository for requirements (system and allocated); provides traceability between system and allocated requirements and between requirements and tests and releases; repository for document control data. The tool used for the requirements repository is CORE.
- HASS change management repository – repository for CCRs (track changes to the requirements and production baselines), PRs (track changes to the test baseline), WRs (track changes to process and development baselines, and working documentation), and AIs (action tracking and disposition). The tool used for the change management repository is NPS Sakai.
- HASS document repository – repository for HASS process baseline and working documentation. The tool used for the document repository is NPS Sakai.
- NPS Sakai– repository for HASS design documentation.

3 Configuration Control

Configuration Control is the systematic proposal, justification, evaluation, coordination, approval or disapproval of proposed changes. Configuration control also includes the implementation of all approved changes to the baseline. The Configuration Control process includes: identification of proposed changes, documentation of proposed changes, evaluation and disposition of proposed changes, and integration of approved changes. These processes are briefly described in the following paragraphs. The CCR Procedure provides the detailed workflow for managing changes to HASS.

3.1 Configuration Identification

There are two HASS baselines defining the deliverable system:

- The requirements baseline is maintained in the HASS requirements repository; it defines the required functional, performance, and operational characteristics of the system.
- The developmental baseline includes the design, integration, and preliminary system test documentation.

CIs are the components of each baseline. All aspects of configuration management apply to these items

The CMO defines the CIs constituting the deliverable system. At the top level, design, integration, and preliminary system test is treated as a CI – changes are managed, tracked, and reported at the HASS level. To provide greater visibility to the stability of the system and its components, the CMO defines lower level CIs such as subsystems, functional areas, hardware components, and, at the lowest level, individual component specifications. This allows version control and reporting at various levels within HASS. The Configuration Management Database (CMDB), described in Section 5.2, maintains the key characteristics of each CI, as defined by the CMO (e.g., hardware model numbers, system release numbers).

The Configuration Item Identification Procedure defines the levels of controlled items, and the procedure and tools for tracking them.

3.2 Identification of Proposed Changes

Changes are permanent alterations to the established baseline (requirements or developmental). A change is proposed when a new requirement is received, an improvement is desired, or a problem requires solution. Changes may be requested by Stakeholders or HASS team members.

An approved CCR generally results in an update to the base lined System Specification. CCR-generated changes that affect documentation or plans include descriptions by the originator of the CCR discussing the impacts. As necessary, the originator of a CCR may generate multiple CCRs to best describe a baseline change. Section 3.5 describes the implementation of approved changes.

Problems identified during system preliminary integration and test, and resolved prior to delivery of the system to STAKEHOLDERS for official testing, are handled by the development and test

teams as PRs under the direction of the Lead Integrator (with PM oversight if necessary). The HASS System Integration and Test Plan describes the management of PRs during testing. Problems identified during system integration and test not resolved prior to delivery become requests for changes to the developmental baseline (i.e., the conceptual/prototype system), and are converted to CCRs when the release is delivered, by decisions made in the Operational Readiness Review (ORR). These new CCRs are reviewed at the next CCB meeting, scheduled for implementation in future releases, and tracked.

3.3 Documentation of Proposed Changes

The CCR Procedure defines the form and workflow for documenting change requests to the system. For system administrative changes refer to the System Administration procedure to determine if a CCR or Work Request (WR) is required to document a proposed change. Errors found during system integration and test, generating changes to HASS, will be documented on a PR according to the Problem Reports procedure.

3.4 Evaluation of Proposed Changes

Each CCR submitted is directed to the HASS System Engineer. The System Engineer reviews the CCR and works with the SET to review or assign a priority, and provide an impact assessment (a rough estimate of the level of effort required for implementation, and impact to other current and planned activities). The System Engineer then notifies the CMO to schedule the CCR for CCB review.

A change priority is assigned to every change request when it is received, as defined in the CCR Procedure. The priority of a CCR is assigned either by the originator or by the System Engineer. The System Engineer has the authority to alter the priority of any CCR. A change required for operations as soon as possible, bypassing the regular release schedule, is assigned an Urgent priority. All changes, regardless of their priority, follow the same approval process, although Urgent CCRs are expedited as described below.

Upon receipt of a new change request, the CCB evaluates the change, contacts the originator of the change if needed, processes the request for a change, and recommends a schedule for implementation of approved changes. The detailed workflow for CCRs is defined in the Configuration Change Request Procedure.

3.4.1 Processing Urgent Changes

A CCR is assigned an Urgent priority when the originator or the System Engineer determines a delay in the implementation would impact the design effort or delay the project. Urgent CCRs are assigned to the System Integration and Test (SIT) TAL who will try to obtain approval out of board from the CCB within two hours. If the TAL is unable to contact the CCB members in a timely fashion, the SIT TAL is authorized to approve implementation of the request. The CCR is formally presented at the next CCB meeting for disposition by the CCB Chair.

3.5 Integration of Approved Changes

The CMO supports the implementation of changes to the requirements and production baselines.

3.5.1 Requirement Baseline Changes

After the CCB approves a change to the requirements baseline, the CCB may assign the change to an analysis team for implementation if the team has not first conducted the requirements review. The analysis team crafts the new requirements and submits them to the PM and stakeholders, as necessary, for review. After CCB approval of the new requirements, the Requirements Manager makes the appropriate changes to the requirements baseline. Once the Requirements Manager makes the changes and establishes the necessary traceability, the System Engineer verifies the change was correctly documented and the CMO closes the CCR. The Requirements Baseline Management Procedure provides details for this process.

Implementation for the new or changed requirement is tracked along with all other requirements. These CCRs are evaluated as described in Section 3.4, and implemented as described in Section 3.5.2, and in the CCR Procedure.

3.5.2 Production Baseline Changes

The CCB assigns each approved CCR to an implementation date or release, and a functional group or subsystem when the CCR is approved. The assignment is reviewed by the CPMT during release planning to verify the scope of the release is acceptable and consistent with current priorities. The development teams implement the assigned CCRs, posting software updates into the source code control repository.

The Lead Integrator is responsible for verifying all scheduled changes are implemented, and for verifying the correct implementation of the changes. Software and database changes are promoted into the test environment after the CMO receives approval to proceed from the SIT TAL. Once the software and database changes are validated in the test environment, they are presented to the Operational Readiness Review (ORR), who determine when all required activities are completed to move the baseline into operations. Once this approval is made and appropriate audits are conducted, verified CCRs are assigned to the HASS CMO, who is responsible for ensuring all change requests assigned to a software release are promoted into the operational system.

After the CMO has promoted the changes to the operational environment and verified the changes are functioning correctly in that environment, the CMO closes the CCR.

Details of the process for implementing changes to the developmental baseline are provided in the HASS Database Configuration Management Procedure and the CCR Procedure.

3.5.3 Process Baseline Changes

Changes proposed to the HASS process baseline (plans and procedures) are documented on WR forms in the HASS change management repository. The originator documents the proposed change and receives approval from the site TAL to proceed. Changes to the process baseline are reviewed by the SET, and then forwarded to the PM only when a recommended disposition is for approval.

Changes proposed to baselined documentation that affects the system are documented on a CCR and submitted to the CCB for review and approval before proceeding.

4 Document and Data Management

This section presents document and data management on HASS.

4.1 Identification

CIs are described according to the HASS Configuration Item Identification procedure.

4.2 Document Management

The primary repository for HASS documents, reports, and other supporting assets for the project (i.e., data and documentation not part of the requirements or developmental baseline) is the HASS Document Repository.

The HASS developmental baseline consists of the plans, designs, models, simulations, and procedures posted under the HASS Baseline Documentation folder. The HASS SET is responsible for development and maintenance of the developmental baseline, with approval by the PM. The detailed procedure for baseline document changes is documented in the Developmental Baseline Management Procedure.

Individual HASS personnel retain hardcopy assets. As needed, the CMO retains hardcopy assets in a central location. Specific electronic assets selected for their privacy, e.g., financial or earned value reporting, may be retained in discrete electronic libraries outside of the HASS Document Repository. Each site is responsible for identifying and controlling these assets.

Other documentation on the project is working documentation that is not part of the deliverable system, and is therefore not included in baselines. This documentation, however, also needs to be managed and controlled to ensure changes are made in an organized manner and the current version is always known and available. Examples of such items are design documentation maintained by the SET, and local plans, policies, procedures, and reports. This documentation is tracked in the HASS configuration management tool, as described in the Document Management Procedure, and managed by the owning team or organization.

4.3 Change Management

Version numbers are assigned by the originator and verified as needed, by the CMO. Version numbers are included in hardcopy assets and managed through the CMO. Entries are maintained in an online catalog.

4.4 Data Management

Data management is the discipline of identifying, scheduling, coordinating, validating, integrating, and controlling project data. Data management includes the timely and economically feasible acquisition of data, ensuring the adequacy of acquired data for its intended use, and managing data after its receipt.

4.4.1 Responsibilities

The CMO is responsible for managing contract data. Data management includes:

- Identifying, collecting, logging, and controlling project documents, records, and correspondence
- Establishing and administering project libraries
- Maintaining the project's configuration management records
- Ensuring a historical log of all changes integrated into software support libraries subject to project-level configuration control is conducted
- Maintain the system development library under CM version and access control
- Maintain records management

4.4.2 Data Acquisition

The CMO will ensure that HASS-related data will be inventoried, categorized, and provided configuration identification according to the HASS Configuration Item Identification procedure. The CMO will ensure that all critical project documentation, including system-related and project-specific assets will be identified.

All identified information will be retained in explicit CM-controlled repositories. Throughout all phases of HASS, all acquired data, including all revisions to this information, will be maintained and controlled. The CMO will manage data based on the source and format depicted in the Table 3.

Table 3 List of Managed Documentation

Description	Control
Action Item Management	Sakai
Risk Management	Sakai
Control Records – CCR/WR/PR	Sakai
Design Documentation	Sakai
Documentation Control (assigned document control numbers) • Plans • Procedures • Concept of Operations • Guides • Requirements Reports and Documents • Charters • Design Documents • Studies • Interface Control Documents	Sakai
Financial and Contractual	Sakai
Intergroup Assets	Sakai
Electronic Project Documentation (storage) • Plans • Procedures	Sakai

Description	Control
• Technical Reference • Meeting Documentation	
Measurements	Sakau
Quality Records	Sakai
Requirements	Sakai and CORE
Document Files, Reference Files	Sakai
System Descriptions	Sakai
Weekly and Monthly Status Reports	Sakai
Project Schedules	Sakai

5 Configuration Status Accounting

Configuration Status Accounting includes the collection, processing, maintaining and publishing data necessary to effectively manage the configuration.

5.1 Status Account Data

The CMO collects data necessary to produce reports useful to the PM, CCB, and Lead Integrator.

For change management, the CMO collects identifying information pertaining to each CCR received and its status in the CCR database, as defined in the CCR Procedure. The CMO prepares defined reports that are available online through the change management tool, in addition to the ad hoc reporting capability of the tool. The System Engineer works with the SET to prepare an assessment report on new CCRs for each CCB meeting. The assessment reports are posted in the CCB area of HASS Document Repository along with the agendas and minutes from the CCB meetings.

For configuration item status, the CMO collects identifying information pertaining to each controlled configuration item, i.e., current revision, revision history, associated subsystem. At the end of each release, the CIs are updated as defined in the Configuration Item Identification Procedure. The CMO prepares reports as requested on CI status, detailing new change requests, newly approved change requests, and closed change requests. Release reports are prepared by the CMO for input into release measurement reports.

5.2 HASS Configuration Management Database

The HASS CMDB contains detailed information about every HASS configuration item; it is used for status reporting. The CMO is responsible for maintaining, supporting and updating the HASS CMDB.

6 Configuration Audits

Configuration audits consist of reviews where the CM process or a product configuration is compared to requirements to determine if those requirements are being met.

6.1 CM Process Audits

Process audits confirm the CM process is being followed. These audits focus on the processes being used rather than on the products being produced. They examine the manner in which the CM activities are performed against the documented procedures. The quality management office (QMO) conducts these audits on a regular basis during the course of the project to allow for problem identification and corrective action.

6.2 CM Baseline Audit

The CMO works with the Lead Integrator and the QMO to conduct a baseline audit for each release, as described in the HASS CM Audits Procedure. This baseline audit verifies the release contents are complete, and all changes to be promoted to operations have been verified by the independent test team.

6.3 Operational Readiness Reviews (ORR)

The CMO works with Systems Integration and Test to participate in release Operational Readiness Reviews. The participation of the ORR includes PM, HASS Operational Team (COT), CCB, QMO, and CMO members. The ORR membership determines the status of release activities and the approval when a release will be moved into the operational environment.

APPENDIX G: TEST PLAN

Humanitarian Assistance Shelter System (HASS)

Detailed Test Plan

August 2011

Table of Contents

List of Tables

Preface

This report describes the detailed test plan for the Humanitarian Assistance Shelter System (HASS). This is an abbreviated test conducted as part of a rapid prototyping and fielding effort. The HASS is based on components selected following an analysis of alternatives. Further refinement to the HASS may occur as a result of the prototype testing. This testing is being conducted to evaluate the HASS based on its performance and relevance for housing a family of five to ten people during disaster relief operations in the transition period between emergency shelter and permanent housing.

OPERATIONAL PERFORMANCE OF THE HASS

1 Introduction

In order to support possible future U.S Government and Non-Governmental Organization (NGO) humanitarian missions, a transition shelter is needed. A capability gap exists in humanitarian shelters as there is not a universally accepted system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years).

Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used.

Based on these and other requirements, a prototype system has been created. This document describes the detailed test plans for that prototype system.

1.1 Tests Performed

Due to the rapid prototyping nature of the HASS project, and abbreviated set of tests is being conducted. Not all requirements are being tested. Based on this initial testing, further refinement of the prototype concept will occur. In the future, full scale testing will need to be conducted.

Table 1 shows each requirement identified in the system specification for the HASS. The final column indicates whether this test plan provides full testing, partial testing, or no testing at all for the given requirement. Section 4 of the system specification provides further details about test methods and requirements for future full scale testing.

Table 1: Test Coverage

Title	Requirement Section	Test Coverage
Environmental Operating Conditions	**3.2**	
Temperature	3.2.1	-
Rain	3.2.2	-
Sand Conditions	3.2.3	-
Dust Conditions	3.2.4	-
Icing Conditions	3.2.5	-
Humidity	3.2.6	-
Fungus	3.2.7	-
Mold	3.2.8	-

Title	Requirement Section	Test Coverage
Mildew	3.2.9	-
Wind	3.2.10	-
Snow	3.2.11	-
Salt Fog	3.2.12	-
Performance Requirements	3.3	-
Operational Lifecycle	3.3.1	-
Operating Terrain	3.3.2	Partial
Water-resistant	3.3.3	-
Reliability	3.3.4	-
Mean Active Maintenance Time (M).	3.3.4.1	-
Corrective Maintenance.	3.3.4.2	-
Mean Time Between Preventive Maintenance	3.3.4.3	-
Vibration	3.3.5	-
Altitude	3.3.6	-
Long Term Storage Needs	3.3.7	-
HASS Assembly	3.3.8	Full
HASS Operation	3.3.9	Full
Design	**3.4**	
Shelter Capability	3.4.1	Full
Materials	3.4.2	Partial
Material Sources	3.4.2.1	Full
COTS Material and Component Selection	3.4.2.2	Partial
Flammable Liquids and Materials	3.4.2.3	-
Toxicity of Materials	3.4.2.4	-
Treatment and Painting of Materials	3.4.2.5	-
Color	3.4.3	Partial
Labeling	3.4.4	-
Transport	3.4.5	Partial
Transportation Configuration	3.4.5.1	Full
Forklift	3.4.5.1.1	Partial
Food Preparation and Storage	3.4.6	
Food Storage Equipment	3.4.6.1	Full
Food Storage Equipment Volume	3.4.6.1.1	Full
Food Storage Equipment Quantity	3.4.6.1.2	Full
Food Preparation and Distribution Kits	3.4.6.2	Full
Food Preparation and Distribution Kit Material.	3.4.6.2.1	Full
Food Preparation and Distribution Kit Type	3.4.6.2.2	Full
Food Preparation	3.4.6.3	Full
Food Preparation Equipment Heat Transfer	3.4.6.3.1	Full

Title	Requirement Section	Test Coverage
Performance		
Food Preparation Equipment Surface Area Performance	3.4.6.3.2	Full
Food Preparation Equipment Cooking Surface Material	3.4.6.3.3	Full
Food Preparation Equipment Efficiency	3.4.6.3.4	Full
Water Purification, Storage, and Distribution	3.4.7	
Water Purification Temperature	3.4.7.1	-
Water Purification Rate	3.4.7.2	-
Water Purification Quality	3.4.7.3	-
Water Storage Volume	3.4.7.4	Full
Water Storage Weight	3.4.7.5	Full
Water Storage Quality	3.4.7.6	Full
Water Storage Distribution	3.4.7.7	Full
Communications	3.4.8	-
Natural Lighting	3.4.9	Full
Artificial Lighting	3.4.10	Full
Electrical Cables/Cords of Artificial Lighting	3.4.10.1	-
Occupant Privacy	3.4.11	-
Divider Volume Division	3.4.11.1	Partial
Ventilation Provisions	3.4.12	-
Ventilation Size	3.4.12.1	Full
Ventilation Performance	3.4.12.2	-
Ventilation Securing Provisions	3.4.12.3	Full
Scalability and Modularity	3.4.13	-
Scalability and Modularity Interface Size	3.4.13.1	-
Human Factors	**3.4.14**	
General	3.4.14.1	-
Ingress/Egress	3.4.14.2	Full
Emergency Egress Time	3.4.14.3	Partial
Major Assembly Weight	3.4.14.4	
Safety	**3.4.15**	
Operational Safety	3.4.15.1	-
Operational Safety Hazards	3.4.15.2	Partial
Sharp Edges and Corners	3.4.15.3	Partial
Moving Parts	3.4.15.4	Partial
Storage and Transportation Safety	3.4.15.5	Partial
Vector-Born Disease	3.4.15.6	Partial
Unsafe Conditions during Maintenance	3.4.15.7	Partial
Component Location Safety	3.4.15.8	Partial

Title	Requirement Section	Test Coverage
Toxic Gases	3.4.15.9	-
Security	3.4.15.10	-

2 Test Procedures

The individual test procedures to be conducted are described below. For each test, there is a preparation section that describes things that need to be accomplished before the test begins, such as selection of a test site with certain parameters, or accomplishment of pre-test set-up. There is an equipment section that lists equipment or supplies needed to conduct the test. Finally, the individual steps of each test procedure are shown in table form, with a second column clearly indicating the need for recorded results or data.

2.1 Shelter Set-up and Inspection Test

2.1.1 Preparation

The following items shall be accomplished before the test begins:

a) HASS in transport configuration.
b) Site with even terrain selected for set-up.

2.1.2 Equipment

This test requires the following equipment:

a) HASS shelter and components
b) Level
c) Light meter
d) 48" x 45" standard pallet with forklift pocket dimensions IAW ISO Standard 1496-1 (1990)
e) Forklift
f) 20’ tape measure
g) Stopwatch

2.1.3 Procedure

Table 2 shows the steps of the test procedure. Record the results as indicated in the “Results” column.

Table 2. Shelter Set-up and Inspection Steps

Step	Results
1. Arrange HASS components on the minimum number of pallets required for safe transportation.	Number of pallets required:

Step	Results
	Record the length, width, and height of each loaded pallet:
2. Verify by inspection that the palletized HASS will fit in an 8' x 8' x 20' ISO container.	Record results:
3. Lift loaded pallet off the ground using forklift, move the load at least 20', and then set it down. Check for damage to the palletized HASS. Repeat for each pallet.	Record results:
4. Move the HASS to the site selected for setup.	Record the terrain conditions (grassy, muddy, etc.): Record the slope of the ground (rise in inches over 20' of ground):
5. Erect the HASS shelter. Level the HASS shelter.	Record the slope of a horizontal frame component:
6. Determine by inspection if the HASS frame provides attachment points for attaching locally available shelter materials (e.g., plywood, corrugated sheet metal).	Record results:
7. Install all available HASS components in the HASS shelter.	
8. Observe the color of the HASS when viewed from outside the shelter.	Record results:
9. Measure the internal living dimensions of the HASS.	Record results:
10. During daylight hours, with artificial lighting turned off, measure the available light at ground level in the center of the shelter , and at ground level in direct sunlight outside the shelter.	Available light at ground level in the center of the shelter (in lux): Available light at ground level in direct sunlight outside the shelter: Time:

UNCLASSIFIED

Step	Results
	General weather conditions:
11. Close/secure all sources of natural lighting. Measure the available light at ground level in the center of the shelter (in lux).	Available light at ground level in the center of the shelter (in lux):
12. Choose a lux value halfway between the values recorded in steps 10 and 11 above. Configure natural lighting closures in order to provide interior natural light at that level.	Record results:
13. Attach the HASS artificial lighting system to the shelter. Verify by inspection and analysis that the artificial lighting provisions are adequate.	Record results:
14. Measure and record the dimensions of all unobstructed ventilation openings.	Record results:
15. Close and secure all ventilation openings.	Record results:
16. Install HASS internal dividers so as to partition approximately ¼ of the total HASS volume. Determine by inspection whether or not cross-ventilation is adversely affected.	Record results:
17. Remove HASS internal dividers.	
18. Determine measurements of doorway.	Height: Width:
19. Position three people reclined on the floor at the furthest point in the shelter from a closed door.	
20. At a signal, the three shelter "occupants" shall expeditiously exit the shelter.	Time for all occupants to exit the shelter:
21. Inspect the shelter for tripping hazards such as thresholds, cords, steps, and other projections.	Record results:
22. Inspect the shelter for sharp edges and projections.	Record results:

Step	Results
23. Inspect the shelter for moving parts which could injure personnel.	Record results:
24. Determine by visual inspection whether or not the HASS prevents the entrance of snakes, mice, scorpions, and mosquitoes.	Record results:
25. Determine by visual inspection whether or not occupants are able to maintain the components of the HASS without being exposed to unsafe conditions.	Record results:
26. Determine by visual inspection whether or not components can be located inside the shelter in order to prevent injury to occupants in case of emergency.	Record results:

2.2 Artificial Lighting Test

2.2.1 Preparation

The following items shall be accomplished before the test begins:

a) Select a location with near-total darkness.

b) Light batteries must be charged via solar chargers.

2.2.2 Equipment

This test requires the following equipment:

a) HASS artificial lights

b) Light meter

2.2.3 Procedure

Table 3 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 3. Artificial Lighting Steps

Step	Results
1. In a dark environment, with lights set to their brightest setting, measure the light available from the HASS artificial lighting (in lux) from 8' away.	Light from all five lights simultaneously: Light from one light:

2.3 Food Storage Equipment Test

2.3.1 Preparation

The following items shall be accomplished before the test begins:
a) Procure a clean water source.

2.3.2 Equipment

This test requires the following equipment:
a) HASS food storage equipment
b) Paper towels
c) Ten gallon bucket

2.3.3 Procedure

Table 4 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 4. Food Storage Equipment Steps

Step	Results
1. Fill 10 gallon bucket with clean water.	
2. Crumple paper towels and insert them into 1 of each type of food container.	
3. Place lid on each type of container and make sure lid is securely attached.	
4. Submerge each type of food container into the 10 gallon bucket. Hold for 10 seconds and remove.	
5. Remove lids from each type of food container.	
6. Remove paper towels from each type of food container.	
7. Inspect each paper towel from each food container; note if paper towel has absorbed any water and from which type of container it came from.	Record results:

2.4 Food Storage Equipment Volume Test

2.4.1 Preparation

The following items shall be accomplished before the test begins:
a) Procure a clean water source.

2.4.2 Equipment

This test requires the following equipment:
a) HASS food storage equipment
b) Measuring pitcher

2.4.3 Procedure

Table 5 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 5. Food Storage Equipment Volume Steps

Step	Results
1. Fill measuring pitcher with clean water to the largest volume possible which is equal to or lesser than 6 qt.	
2. Transfer contents of measuring pitcher into each type of food storage container one at a time until each food storage container contains 6 qt of water each.	
3. Note if any food storage containers overflow and can't contain 6 qt of water.	Record results:

2.5 Food Storage Equipment Quantity Test

2.5.1 Preparation

None.

2.5.2 Equipment

This test requires the following equipment:
a) HASS food storage equipment

2.5.3 Procedure

Table 6 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 6. Food Storage Equipment Quantity Steps

Step	Results
1. Determine quantity of food storage containers present upon delivery.	Record results:

2.6 Food Preparation and Distribution Quantity Test

2.6.1 Preparation

The following items shall be accomplished before the test begins:
None.

2.6.2 Equipment

This test requires the following equipment:
a) HASS food preparation and distribution equipment

2.6.3 Procedure

Table 7 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 7. Food Preparation and Distribution Quantity Steps

Step	Results
1. Determine quantity of each type of food preparation and distribution equipment present upon delivery.	Record results:

2.7 Food Preparation and Distribution Kit Material Test

2.7.1 Preparation

The following items shall be accomplished before the test begins:
None.

2.7.2 Equipment

This test requires the following equipment:
a) HASS food preparation and distribution kit

2.7.3 Procedure

Table 8 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 8. Food Preparation and Distribution Kit Material Steps

Step	Results
1. Determine material type from manufacturer packaging or manual for each piece of equipment in the food preparation and distribution kit.	Record results:

2.8 Food Preparation Boil Test

2.8.1 Preparation

The following items shall be accomplished before the test begins:
a) Test site with adequate ventilation and approximately 100 square feet of test space.
b) Procure a clean water source.

2.8.2 Equipment

This test requires the following equipment:
a) HASS food preparation equipment
b) 11 quart aluminum stock pot with lid.
c) Data logging equipment with at least 1 thermocouple input
d) 15 lb propane tank
e) 4 lbs of charcoal
f) 3 lbs of dry wood
g) Electronic ignition grill lighter
h) Lighter fluid

2.8.3 Procedure

Table 9 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 9. Food Preparation Boil Steps

Step	Results
1. Light the stove with 4 pounds of charcoal fuel and allow to burn for fifteen minutes.	
2. Place an 11 quart aluminum stock pot on the stove with approximately 2.5 gallons of tap water contained within the stock pot at an initial temperature of 80°F ±5°F.	

Step	Results
3. Cover the stock pot with a lid.	
4. With the data logging unit activated, allow the water to reach a temperature of 212°F or remain on the stove for one hour; whichever comes first	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:
5. Repeat steps 1-4 while using the Volcano II baking lid.	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:
6. Light the stove with propane and allow to burn for five minutes.	
7. Place an 11 quart aluminum stock pot on the stove with approximately 2.5 gallons of tap water contained within the stock pot at an initial temperature of 80°F ±5°F.	
8. Cover the stock pot with a lid.	
9. With the data logging unit activated, allow the water to reach a temperature of 212°F or remain on the stove for one hour; whichever comes first.	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:
10. Repeat steps 6-9 while using the Volcano II baking lid.	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:
11. Light the stove with 3 pounds of wood and allow to burn for five minutes.	
12. Place an 11 quart aluminum stock pot on the stove with approximately 2.5 gallons of tap water contained within the stock pot at an initial temperature of 80°F ±5°F.	
13. Cover the stock pot with a lid.	
14. With the data logging unit activated, allow the water to reach a temperature of 212°F or remain on the stove for one hour; whichever comes first.	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:

Step	Results
15. Repeat steps 11-14 while using the Volcano II baking lid.	Record the time it takes to raise the water temperature from its start point to 212°F. If the water does not reach 212°F in 1 hour, record the maximum temperature reached:

2.9 Food Preparation (Braising, Pan-Frying, and Griddling) Test

2.9.1 Preparation

The following items shall be accomplished before the test begins:

a) Test site with adequate ventilation and approximately 100 square feet of test space.

2.9.2 Equipment

This test requires the following equipment:

a) HASS food preparation equipment
b) 15 in non-stick skillet
c) 15 lb propane tank
d) 4 lbs of charcoal
e) 3 lbs of dry wood
f) Electronic ignition grill lighter
g) Lighter fluid
h) 3 - 32 oz egg beaters egg mix
i) Spatula

2.9.3 Procedure

Table 10 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 10. Food Preparation (Braising, Pan-Frying, and Griddling) Steps

Step	Results
1. Remove the Volcano II top grill.	
2. Light the stove with 4 pounds of charcoal fuel and allow to burn for fifteen minutes.	
3. Place a 15 inch non-stick skillet into the top of the Volcano II.	
4. Pour approximately 32 oz of egg beaters egg mix into the skillet.	
5. Cook the egg mix to a consumable	Record the time required to cook the egg mix

Step	Results
consistency.	to a consumable consistency:
6. Light the stove with propane and allow to burn for five minutes.	
7. Place a 15 inch non-stick skillet into the top of the Volcano II.	
8. Pour approximately 32 oz of egg beaters egg mix into the skillet.	
9. Cook the egg mix to a consumable consistency.	Record the time required to cook the egg mix to a consumable consistency:
10. Light the stove with 3 pounds of wood and allow to burn for five minutes.	
11. Place a 15 inch non-stick skillet into the top of the Volcano II.	
12. Pour approximately 32 oz of egg beaters egg mix into the skillet.	
13. Cook the egg mix to a consumable consistency.	Record the time required to cook the egg mix to a consumable consistency:

2.10 Food Preparation Equipment Surface Area Performance Test

2.10.1 Preparation

The following items shall be accomplished before the test begins:
a) Test site with adequate ventilation and approximately 100 square feet of test space.

2.10.2 Equipment

This test requires the following equipment:
a) HASS food preparation equipment
b) 15 lb propane tank
c) 10 hamburgers which are 151g (ea)
d) Spatula
e) NSF certified meat thermometer

2.10.3 Procedure

Table 11 shows the steps of the test procedure. Record the results as indicated in the “Results” column.

Table 11. Food Preparation Equipment Surface Area Performance Steps

Step	Results
1. Place the Volcano II top grate onto the stove and light the grill in an outdoor environment with propane.	
2. Pre-heat the grill for approximately 5 minutes.	
3. Place 5 refrigerated hamburgers onto the grill until the grill's cooking space is completely utilized.	
4. Cook the hamburgers until their internal temperature reaches 160°F.	Cooking time:
5. Remove the hamburgers.	Grill surface temperature:
6. Continuously monitor the surface temperature of the grill until the temperature returns to 375°F.	Recovery time:
7. Place 5 frozen hamburgers onto the grill until the grill's cooking space is completely utilized.	
8. Cook the hamburgers until their internal temperature reaches 160°F.	Cooking time:
9. Remove the hamburgers.	

2.11 Food Preparation Equipment Cooking Surface Material Test

2.11.1 Preparation

The following items shall be accomplished before the test begins:
None.

2.11.2 Equipment

This test requires the following equipment:
a) HASS food preparation equipment

2.11.3 Procedure

Table 12 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 12. Food Preparation Equipment Cooking Surface Material Steps

Step	Results
1. Determine the material type of the cooking surface from manufacturer packaging or manual for each piece food preparation equipment	Record results:

2.12 Water Storage Equipment Inspection and Weight Test

2.12.1 Preparation

The following items shall be accomplished before the test begins:
a) Remove water bag from shipping container.

2.12.2 Equipment

This test requires the following equipment:
a) High Stress Collapsible Water Bag (HSCWB)
b) Still camera
c) Calibrated scale 0-20 pounds

2.12.3 Procedure

Table 13 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 13. Water Storage Equipment Inspection and Weight Steps

Step	Results
1. Visually inspect and operational check out all the components of the water bag.	
2. Inventory all water bag components.	
3. Photograph test items.	
4. Examine each component visually to defects or evidence of damage that may have occurred due to shipping and handling.	Record results:
5. Weigh the water bag with all its components installed.	Record results:

2.13 Water Storage Equipment Leakage Test

2.13.1 Preparation

The following items shall be accomplished before the test begins:

a) Clean water at 73°F +/-3°F, adequate volume to fill a 5-gallon bag.

2.13.2 Equipment

This test requires the following equipment:

a) High Stress Collapsible Water Bag (HSCWB)

b) Calibrated thermocouples

2.13.3 Procedure

Table 14Table 2 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 14. Water Storage Equipment Leakage Steps

Step	Results
1. Fill water bag with clean water at 73°F to 5 gallons.	
2. Screw down the cap.	
3. Set the water bag on its bottom for 10 minutes.	
4. Examine for any leakage or presence of moisture.	Record results:
5. Rotate the water bag 180°, with its cap facing down for not less than 30 minutes.	
6. Examine for any leakage or presence of moisture.	Record results:

2.14 Water Storage Equipment Ambient Test

2.14.1 Preparation

The following items shall be accomplished before the test begins:

a) Clean water at temperatures of 125°F, and -10°F, adequate volume to fill a 5-gallon bag.

2.14.2 Equipment

This test requires the following equipment:

a) High Stress Collapsible Water Bag (HSCWB)
b) Calibrated thermocouples
c) Calibrated thermostat
d) Panasonic Video Camera
e) HP Agilent Data Logger, Model 39740A
f) YSI Professional Plus

2.14.3 Procedure

Table 15Table 2 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 15. Water Storage Equipment Ambient Steps

Step	Results
1. Instrument the interior of water bag with three type-K thermocouples.	
2. Adjust the thermostat as needed to allow the climatic chamber's ambient temperature to reach 115°F.	
3. Fill water bag with clean water at 125°F to 5 gallons.	
4. Conduct testing for 24 hours.	Record the water temperature at 5 minute intervals during soak periods. Record ambient temperature samples with the data logger every 5 minutes.
5. Repeat steps 1-4 for water at -10°F.	Record the water temperature at 5 minute intervals during soak periods. Record ambient temperature samples with the data logger every 5 minutes.

2.15 Water Storage Equipment Quality (Potability) Test

2.15.1 Preparation

The following items shall be accomplished before the test begins:
None.

2.15.2 *Equipment*

This test requires the following equipment:
a) High Stress Collapsible Water Bag (HSCWB)
b) Calibrated thermocouples
c) Calibrated thermostat
d) Panasonic Video Camera
e) HP Agilent Data Logger, Model 39740A
f) YSI Professional Plus

2.15.3 *Procedure*

Table 16 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 16. Water Storage Equipment Quality (Potability) Steps

Step	Results
1. Fill water bag with clean water at 125°F to 5 gallons.	
2. Wait 24 hours.	Record color (color unit), odor (threshold odor number), pH, TDS (mg/L), turbidity (NTU), arsenic (mg/L), chloride (mg/L), and sulfate (mg/L):
3. Repeat steps 1-2 for water at 12°F.	Record color (color unit), odor (threshold odor number), pH, TDS (mg/L), turbidity (NTU), arsenic (mg/L), chloride (mg/L), and sulfate (mg/L):
4. Compare both results with the DOD Tri-Service regulations.	Record results:

2.16 Water Storage Equipment Material Test

2.16.1 Preparation

The following items shall be accomplished before the test begins:
None.

2.16.2 Equipment

This test requires the following equipment:
a) High Stress Collapsible Water Bag (HSCWB)

2.16.3 Procedure

Table 17 shows the steps of the test procedure. Record the results as indicated in the “Results” column.

Table 17. Water Storage Equipment Material Steps

Step	Results
1. Determine material type from manufacturer packaging or manual for each piece of equipment in the water storage equipment kit.	Record results:

APPENDIX H: TEST RESULTS

Humanitarian Assistance Shelter System (HASS)

Shelter and Lighting Test Results

August 2011

Table of Contents

List of Tables

List of Figures

Preface

This report describes the results of the testing described in the HASS Detailed Test Plan for the Humanitarian Assistance Shelter System (HASS). This is an abbreviated test conducted as part of a rapid prototyping and fielding effort. The HASS is based on components selected following an analysis of alternatives. Further refinement to the HASS may occur as a result of the prototype testing. This testing was conducted to evaluate the HASS based on its performance and relevance for housing a family of five to ten people during disaster relief operations in the transition period between emergency shelter and permanent housing.

OPERATIONAL PERFORMANCE OF THE HASS

1 Introduction

In order to support possible future U.S Government and NGO humanitarian missions, a transition shelter is needed. A capability gap exists in humanitarian shelters as there is not a universally accepted system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years).

Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used.

Based on these and other requirements, a prototype system has been created. This document describes results from testing of the shelter and associated components in accordance with the HASS Detailed Test Plan. Results for food storage equipment, food preparation equipment, and water storage equipment were prepared separately.

1.1 Tests Performed

Due to the rapid prototyping nature of the HASS project, an abbreviated set of tests was conducted. Not all requirements were tested. Based on this initial testing, further refinement of the prototype concept will occur. In the future, full scale testing will need to be conducted.

2 Test Procedures

The individual test procedures conducted are described below, with results. For each test, there is a Preparation section that describes things that need to be accomplished before the test begins, such as selection of a test site with certain parameters, or accomplishment of pre-test set-up. There is an Equipment section that lists equipment or supplies needed to conduct the test. Finally, the individual steps of each test procedure are shown in table form, with a second column clearly indicating recorded results or data.

The tests documented below were conducted on Friday, 12 August, 2011, beginning at approximately 9:30 am. The test site was on Hospital Point at Marine Corps Base Quantico in Quantico, Virginia.

2.1 Shelter Set-up and Inspection Test

2.1.1 Preparation

The following items shall be accomplished before the test begins:

a) HASS in transport configuration.
b) Site with even terrain selected for set-up.

2.1.2 Equipment

This test requires the following equipment:

a) HASS shelter and components
b) Level
c) Light meter
d) 48" x 45" standard pallet with forklift pocket dimensions IAW ISO Standard 1496-1 (1990)
e) Forklift
f) 20’ tape measure
g) Stopwatch

2.1.3 Procedure

Table 1 shows the steps of the test procedure. Record the results as indicated in the “Results” column.

Table 1. Shelter Set-up and Inspection Steps

Step	Results
1. Arrange HASS components on the minimum number of pallets required for safe transportation.	Number of pallets required: 2 pallet positions. Most of the components will fit on one pallet (perhaps inside of a 30” triwall), but the frame takes about one-and-a-half pallet positions due to its length. Record the length, width, and height of each loaded pallet: 48” x 45” x 30” (approximately)
2. Verify by inspection that the palletized HASS will fit in an 8' x 8' x 20' ISO container.	Record results: Yes, it will fit.
3. Lift loaded pallet off the ground using forklift, move the load at least 20’, and then set it down. Check for damage to the palletized HASS. Repeat for each pallet.	Record results: No damage was observed.
4. Move the HASS to the site selected for setup.	Record the terrain conditions (grassy, muddy, etc.): Grassy, relatively level/flat with minor depressions and bumps. Record the slope of the ground (rise in inches over 20’ of ground): No slope. (Zero inches over twenty feet.)

Step	Results
5. Erect the HASS shelter. Level the HASS shelter.	Record the slope of a horizontal frame component: No slope. The shelter was erected over level ground. The shelter is not actually able to be leveled, as noted in next section of the report.
6. Determine by inspection if the HASS frame provides attachment points for attaching locally available shelter materials (e.g., plywood, corrugated sheet metal).	Record results: The frame does not provide attachment points. However, it seems that the frame could be modified to accept locally available building materials, perhaps by pre-drilling holes for screws at various points on the frame.
7. Install all available HASS components in the HASS shelter.	
8. Observe the color of the HASS when viewed from outside the shelter.	Record results: Nearly white, or off-white.
9. Measure the internal living dimensions of the HASS.	Record results: Width = 187” Length = 192” Height at center = 95” Height at side walls = 63”
10. During daylight hours, with artificial lighting turned off, measure the available light at ground level in the center of the shelter , and at ground level in direct sunlight outside the shelter.	Available light at ground level in the center of the shelter (in lux): 1115 lux (peak) Available light at ground level in direct sunlight outside the shelter: Shade = 9,560 lux Direct sunlight = 115,800 lux Time: 12:50 pm General weather conditions: Mostly sunny, few clouds
11. Close/secure all sources of natural lighting. Measure the available light at ground level in the center of the shelter (in lux).	Available light at ground level in the center of the shelter (in lux): 972 lux (peak)
12. Choose a Lux value halfway between the values recorded in steps 10 and 11 above. Configure natural lighting closures in order to provide interior natural light at that level.	Record results: This was achieved by closing one shelter door and two windows on the prevailing sun side of the shelter.
13. Attach the HASS artificial lighting system to the shelter. Verify by inspection and analysis that	Record results: The shelter comes with a liner, which is very

Step	Results
the artificial lighting provisions are adequate.	desirable since it helps to insulate the shelter and provide privacy at night. With the liner in place, there are no attachment points for lighting. Therefore, the artificial lighting provisions are not adequate.
14. Measure and record the dimensions of all unobstructed ventilation openings.	Record results: Two windows in the long walls of the shelter, each 10.5" x 84" Four windows in the shelter doors (2 each), each 17" x 39" One 5" diameter cooking vent
15. Close and secure all ventilation openings.	Record results: All ventilation openings are easy to secure.
16. Install HASS internal dividers so as to partition approximately ¼ of the total HASS volume. Determine by inspection whether or not cross-ventilation is adversely affected.	Record results: This is not possible with the liner in place. We removed the liner in order to accomplish this test, and then the divider worked as designed. The shelter can be partitioned to make a room one-quarter the total size of the shelter on either end, or it can be divided in half. Cross ventilation is reduced with the divider in place; however, it is possible to set up the divider in such a way as to still provide substantial cross ventilation.
17. Remove HASS internal dividers.	
18. Determine measurements of doorway.	Height: 78" Width: 44" There is a 9" threshold by the doorway. For purposes of egress, it would be easy for most occupants to step over this threshold; however, it is a trip hazard, and may cause a problem for some.
19. Position three people reclined on the floor at the furthest point in the shelter from a closed door.	
20. At a signal, the three shelter "occupants" shall expeditiously exit the shelter.	Time for all occupants to exit the shelter: 8.7 seconds
21. Inspect the shelter for tripping hazards such as thresholds, cords, steps, and other projections.	Record results: The doorway thresholds are a trip hazard. The floor is loose fitting, and may present a trip hazard, but not likely.

Step	Results
22. Inspect the shelter for sharp edges and projections.	Record results: Some during assembly, but none once erected.
23. Inspect the shelter for moving parts which could injure personnel.	Record results: None found.
24. Determine by visual inspection whether or not the HASS prevents the entrance of snakes, mice, scorpions, and mosquitos.	Record results: Protection from insects/vermin is not adequate. At the bottom of the doors, between the door and the threshold, there is an opening which can't be easily secured.
25. Determine by visual inspection whether or not occupants are able to maintain the components of the HASS without being exposed to unsafe conditions.	Record results: There appears to be no problems that would prevent safe maintenance, except perhaps the height of the shelter in the center. A repair at the apex of the shelter may require standing on something to reach the site of the repair.
26. Determine by visual inspection whether or not components can be located inside the shelter in order to prevent injury to occupants in case of emergency.	Record results: No negative observations.

2.2 Artificial Lighting Test

2.2.1 Preparation

The following items shall be accomplished before the test begins:

a) Select a location with near-total darkness.

b) Light batteries must be charged via solar chargers.

2.2.2 Equipment

This test requires the following equipment:

a) HASS artificial lights

b) Light meter

2.2.3 Procedure

Table 2 shows the steps of the test procedure. Record the results as indicated in the "Results" column.

Table 2. Artificial Lighting Steps

Step	Results
1. In a dark environment, with lights set to their brightest setting, measure the light available from the HASS artificial lighting (in lux) from 8’ away.	Light from all five lights simultaneously: 45.7 lux (peak) Light from one light: 14.2 lux (peak)

3 Photographs of Testing

We documented the test process with photographs. Several are included below.

Figure 1 shows the HASS minus the frame, loaded in a 30” triwall on top of a pallet.

Figure 1. The HASS

Figure 2 shows the palletized HASS with the lid removed, exposing the frame.

Figure 2. View of Packaged HASS

Figure 3 shows the forklift test.

Figure 3. The Forklift Test

Figure 4 shows the HASS being loaded into a standard ISO container.

Figure 4. Loading the HASS into a Standard ISO Container

Figure 5 shows the start of the set-up of the HASS with the frame inside the floor.

Figure 5. Starting Set-up

Figure 6 shows the completed HASS.

Figure 6. The Finished Shelter.

Figure 7 shows a stain on the liner. This stain appears to be caused by the rubber gasket around the stove exhaust.

Figure 7. Stained Liner

Figure 8 shows the assembly of the water filtration equipment. Notice the shelter liner in the background.

Figure 8. Assembling the Water Filtration Equipment

Figure 9 shows the effort involved in cranking the radio.

Figure 9. Cranking the Radio

Having cranked the radio, it is now time to test it as shown in

Figure 10.

Figure 10. Testing the Radio.

In

Figure 11 the Volcano II stove is being assembled for use with propane.

Figure 11. Assembling the Volcano II

Figure 12 shows the results of the cookware being bent with bare hands.

Figure 12. Cookware Durability

The cookware lids shattered with a sharp blow as shown in

Figure 13.

Figure 13. Shattered Lids

In Figure 14 the water purification equipment is being tested. Notice the lights indicating that it is working.)

Figure 14. Testing the Water Purification Equipment

Figure 15 shows the assembled water filtration equipment, resting on a box.

Figure 15. Assembled Water Filtration Equipment

In

Figure 16 the water storage containers are shown sitting next to the Volcano II stove in its carrying case.

Figure 16. Water Storage Containers

The lighting equipment selected can also be used to charge a cell phone as shown in

Figure 17.

Figure 17 Charging a Cell Phone

Solar panels are required to charge the artificial lighting as shown in Figure 18.

Figure 18. Solar Panels

Figure 19 shows the measurement test being performed.

Figure 19. Measuring Dimensions of the Doorway Test

Power tools are required to secure some of the brackets as shown in

Figure 20.

Figure 20. Power Tools are Required

Figure 21 shows light readings being taken in direct sunlight using a light meter.

Figure 21. Taking Light Readings

Figure 22 shows the vestibule created when one shelter is connected to another.

Figure 22. A Very Small Vestibule

Unfortunately, the threshold is not secured from snakes, insects, etc, as shown in Figure 23.

Figure 23. Accessibility by Vermin Issues

Figure 24 shows the gap between door and threshold as it naturally lays.

Figure 24. The Gap

In

Figure 25 the partition is being tested. Note that the liner has been removed.

Figure 25. Testing the Partition.

4 Additional Observations and Recommendations

During the testing and use of the HASS, additional observations were made as noted in the following sections. In some cases, recommendations for improvements are included.

4.1 Frame

The shelter frame is definitely one of the most successful and well designed shelter components. It is sturdy, and definitely seems like it could last the objective 5 year lifetime of the system. It comes nicely packaged for transportation, even though the length of some components means that the frame when packaged for transport will not fit on one pallet. The frame is erected easily and quickly.

There are two major drawbacks to the shelter frame. First, it is not able to be leveled. Primarily this is because the frame sits inside the floor of the shelter. There is no way to support one corner or side of the frame without damaging the floor.

The second drawback is that there is no convenient way to attach locally available building materials to the shelter frame to replace the fabric cover as it wears out over time. For example, it would be difficult without power tools to attach a sheet of plywood to the shelter's exterior. This could be easily remedied by pre-drilling attachment points during manufacture.

The shelter frame comes with corner braces, but there is no way of attaching these without a drill. Pre-drilled holes would be a good idea here, too. The corner braces were not necessary for testing, or even continued use of the shelter, but may make the shelter more durable in the long run.

Recommendations:
- Improve the design so that the frame can be leveled without interfering with the floor.
- Pre-drill attachment points for locally available building materials during manufacture.
- Pre-drill holes for attaching the corner braces.

4.2 Packaging

The HASS testing team recommend leaving the frame as packaged by the manufacturer for transport. The remainder of the HASS components could be placed in a 30” triwall atop a standard pallet. This would allow six to seven systems to be shipped in a standard ISO shipping container.

The frame comes banded together with steel bands. One problem noted in unpackaging the system is that no tools are provided to cut the steel bands.

Recommendations:
- Include a pair of tin-snips or similar tool per six or seven shelters.

4.3 Shelter Lining

The shelter comes with a liner, which is very desirable since it helps to insulate the shelter and provide privacy at night. Although testing occurred on a hot day, the internal shelter temperature remained cooler than the outside temperature with the liner in place.

With the liner in place, there are no attachment points for lighting. Also, the fabric divider that comes with the shelter to divide it into partitions cannot be used with the liner in place.

All testers felt that the benefits of the liner outweighed the drawbacks. With the liner in place, however, the requirements with respect to dividing the shelter and attaching artificial lighting can’t be met. It would be preferable if these requirements could be met with the liner in place, but currently the shelter occupants will have to decide which requirements are most important to them.

Recommendations:
- Redesign the liner so that reinforced holes provide access to the frame for attaching lighting or the divider.

4.4 Durability

The shelter is required to last 2.5 (threshold) to 5 (objective) years. Some components of the shelter do not seem to meet this durability requirement based purely on observation over an extremely short period of time. Further testing is required to more accurately determine the durability of the HASS.

Questionable shelter components include the pots and pans, lids to the food storage containers (containers themselves seem fine), and water filtration (not purification) equipment.

Also, the fabric portions of the shelter structure do not seem like they would last the entire time. The floor may be easily torn or punctured during use, or worn out by abrasion against the ground. However, this would not render the shelter unserviceable.

The walls may last with care, but the concept of operations for the HASS would extend the life of the shelter by replacing walls and ceiling over time with locally available building materials, so this is likely not an issue.

During testing, one of the seams holding a piece of Velcro onto a piece of fabric came partially undone while opening a closed ventilation opening.

Recommendations:

- Select an alternate, more durable, set of pots and pans.
- Select an alternate water filter system with greater durability.
- Select an alternate set of food storage containers with more durable lids.
- Adopt previously mentioned recommendations facilitating use of locally available materials.

4.5 Miscellaneous Issues

In addition to being flimsy and not durable, the pots and pans are insufficient for other reasons. The handles appear to transfer heat. They come with glass lids that are easily broken (the testing team shattered one with a sharp blow), creating both a durability problem and a safety issue. The testing team has already recommended selecting a different option for this component.

The water filter needs to sit on something in order to be useful, so that a container can be introduced under the faucet when delivering water. Currently no part of the HASS would be usable for this purpose. The testing team is recommending a more durable water filter, but this could be an issue for any replacement component.

The artificial lighting provided does not meet the requirement for light output. However, in practical use, these lights provide plenty of light for tasks that are likely to be conducted in a dark shelter, such as preparing a meal, moving around, or even doing school work. The present requirement is likely too stringent, and should be revisited.

Recommendations:

- Select an alternate, more durable, set of pots and pans.
- Consider reducing the required output from the artificial lighting.

4.6 Notable Successes

Several components of the HASS stood out in testing as particularly good components. As mentioned, the frame is exceptionally suitable and well designed. With the minor modifications recommended above, the selected frame could be the perfect foundation to a complete shelter system.

Another noteworthy component was the Volcano II tri-fuel stove. This seems like the perfect piece of gear, suitable to a wide range of disaster scenarios. It is efficient and easy to use. It seems durable. Perhaps the only drawback is that it can’t be vented to the outside via the shelter’s cooking vent, and therefore should probably be used outside the shelter for maximum safety of the occupants.

The radio, while only moderately sturdy, was extremely impressive. The test team listened to music during the entire testing operation, and the radio only needed to be hand-cranked twice to provide sufficient electricity. A variety of radio transmissions were detectable.

The lights were also impressive. Charged by included solar panels, the obviated the need for batteries. In addition, the lights came with adapters that could be used to charge a variety of cell phones.

5 Conclusion

The initial HASS prototype successfully passed a majority of the tests conducted. Areas of testing in which the HASS did not sufficiently meet requirements include:

- Requirement 3.4.2.1, Material Sources: Without some design changes, the HASS does not adequately support use of locally available materials in construction. Design changes would likely be minor.
- Requirement 3.4.15.6, Vector-Born Disease: The current HASS design meets this requirement everywhere except at the bottom of the two doors. A design change is needed to fully meet this requirement.

Areas in which the HASS did not meet objective requirements, but met threshold requirements, include:

- Requirement 3.3.2, Operating Terrain: Although the system is not capable of being leveled, it still could likely operate on somewhat uneven terrain. This is certainly not the ideal set-up, and for practical purposes, those erecting the shelter should seek a level site for construction.

Areas in which the HASS technically met requirements, but not sufficiently in our estimation, include:

- Requirements 3.4.11.1, Divider Volume Division, and 3.4.10, Artificial Lighting: Although these requirements are fully met if the HASS is used without the liner, use of the liner is desirable but incompatible with these requirements. Therefore, improvement is needed in this area.

Full-scale testing may reveal further deficiencies. However, none of these seem like insurmountable problems. Ultimately, the HASS prototype performed well in initial testing. We recommend minor modifications to the HASS prototype as described above, and preparation for full-scale testing.

Hydration Waterbags

Camelbak

Harris

Source Vagabond

Purpose: To evaluate overall holding strength of primary front center and top waterbag straps.

Hydration Waterbags

- Test Procedure: Both the Camelbak and Source Vagabond top waterbag handles were attached to an Instron Tensile Tester top grip while bottom grip was connected to front center handle and pulled apart at 20 in / min . The Harris model had no top center strap so it was attached to base of machine while the top strap was pulled up. See photos 1-3.

Camelbak Description

- Front center handle is constructed from 2 inch webbing attached to waterbag outershell with 1 ¾ in square Box –X stitch patterns to form a 6 inch handle. Top handle used 1 1/2 inch webbing formed in a 12 inch loop attached to waterbag via 1 ¼ inch box-x's with loop formation formed via a Quick release buckle. Top Quick release buckle broke at 579 lbs.
- Alternate carry means includes Backpack design along with two sided 12 inch loops with box-x attachments using

one inch webbing .

Photo 1 – Camel bak

Source Vagabond Waterbag

- Front handle uses 2 inch webbing to form a 6 inch long handle attached to waterbag via 1 ¾ inch square Box-x seams. Top handle provides double loops using 2 inch webbing sewn to waterbag with 1 ¾ inch Box-X seams.

  Front handle Box-x seam broke at 305 lbs.

  No damage to the top double strap system.

- Alternate carry means includes a backpack design using one inch webbing with top using 1 inch square Box-X seam.

Photo 2 – Source Vagabond

Harris

- Harris top handle uses 2 inch webbing sewn to waterbag with 1 x 1 ¼ inch Box-X seams. Harris uses no front handle.

Harris top strap Box-x stitches broke at 462 lbs.

- Alternate carry means includes a backpack design using 2 inch wide webbing attached to waterbag using 1 X 1 ½ inch Box-x seams.

Photo 3 – Harris

Hydration Waterbags SUMMARY

Camelbak	Harris	Source Vagabond
579 lbs	462 lbs	305 lbs
Top strap Quick release buckle broke	Top strap Box-x seam broke	Front strap Box-x seam broke

Conclusion: All three waterbags possess significantly strong strap handles to function in the field plus all have alternative means to carry and transport units if primary carry means fails.

SYSTEMS EQUIPMENT AND ENGINEERING TEAM
DOD-COMBAT FEEDING DIRECTORATE
US ARMY NATICK SOLDIER RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

High Stress Collapsible Water Bags (HSCWB)

Performance Testing of HSCWB

Shubham Chandra

June 28, 11

This test report examines the procedures for test and evaluation of 5-Gallon Water bags, in order to meet war fighter requirements.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The High Stress Collapsible Water Bag (HSCWB) will greatly enhance the Warfighter's effectiveness by upgrading the logistical capabilities of transporting water without limiting the resources required to fully support long-range patrols. This container will also allow for more efficient resupply during airdrops because it is able to withstand airdrops from heights as high as 50ft as documented in this test report. Its decreased cubic volume will allow for easier packing of mission-essential materiel (weapons and ammunition), which will translate to increased storage space during transportation. Furthermore, the quality of water will not be sacrificed and would remain safe for consumption, allowing the Warfighter to be more effective by decreasing the risks associated with using local water in remote and undeveloped areas…keeping Warfighters safe, healthy, and in the fight.

1.0 Introduction

Under a Continuous Process Improvement (CPI) program at Natick Soldier Research, Development and Engineering Center (NSRDEC), a High Stress Collapsible Water Bag (HSCWB) was designed to reduce cube storage volume inside infantry patrol vehicles while maintaining the overall quality of the water being stored. The bag is more physically robust than the current 5-gallon plastic water containers used in the field as to prevent damage during quick airdrop techniques from short heights.

The High Stress Collapsible Water Bag (HSCWB) - Alpha version was show cased at the 2008 Modern Day Marine Show, Quantico, VA. The US Marines were very interested in the added features of these bags, and have requested for other features on these bags in support of their pack mule training and air drop delivery of water bags. They also want to test it as a food service equipment item, and test it against other commercially available COTS water bags, including Camelbak's SQUADBACK and CIMA Sport's WXP™ Hydration System to ensure its produce ability and supportability. The Army has also provided valuable input in streamlining the design features for the HSCWB – Beta version, to enhance the capabilities of the Warfighter.

1.1 Background

The 5-gallon water container currently used by the armed services was developed in 1966, which consist of a high density polyethylene copolymer resin body coupled with a low density virgin polyethylene cap (1), has served the armed services for more than four decades. The container is rugged, bag withstand drops from as high as six feet, and has a proven track record as being durable and reliable container. Water is transported to remote locations and Observations Posts

primarily using multiple 5 gal cans or similar capacity containers. These items are transported through a combination or ground vehicles and rotary winged aircraft. These day and night time resupply missions often require rotary winged aircraft to deliver water to austere locations without the possibility of landing to off load. Water containers are typically dropped from altitudes ranging from 35 – 55 ft AGL. Load survivability rates are low creating a draw on air With today's demand to reduce logistics capability, there is a need for a product which would enhance the War fighter's mission by upgrading the logistical capabilities of transporting water without limiting the resources required to fully support long-range patrols and allow for more efficient resupply during airdrops since it will be able to withstand airdrops from heights as high as 35-50ft. It will also make the War fighter's task easier to pack out mission-essential materiel (weapons and ammunition), which could translate to increased storage space during transportation and potentially extend their deployment by reducing logistical support.

1.2 Objectives

The objective of this testing is to compare the performance of HSCWB, and evaluate its ability to meet the requirements of the war fighter.

2. Appliance (s) Description

Apart from the HSCWB other COTS bags including CIMA Sport's WXP™ Hydration System and SQUADBAK were also tested but failed to withstand 35 feet drop on concrete.

High Stress Collapsible Water Bag (HSCWB)

Figure 1: HSCWB

Base Fabric. 1050 denier ballistic nylon coated on the outside with urethane for rugged endurance and silicone on the inside for compliance with CFR Title 21 for potable water.

Hardware. A single fitting has a 4” opening to facilitate clean out and sanitization between uses. An integral ¾” threaded plug allows for attachment of a spigot or garden hose. Dispensing tubes with shut-off fittings are compatible with hydration units currently in the US military inventory, including Quick Disconnects to attach to M-40 and M-51 drink tubes, as well as 3 liter individual hydration units. All hardware meets CFR Title 21.

Strapping/Grommets. Unit has padded straps so it bag be worn on the back and carried by an individual. Handles are also included so it bag be carried by two soldiers. Grommets included on one end allows for hanging the unit when practical, Photo 1.

SQUADBAK

Figure 2: SQUADBAK Bag

Materials

1000D Dupont Cordura™ front, back, shoulder strap front, reservoir exit port flap cover and crossbar panel

Nylon 420d HD reservoir opening edge binding, Shoulder strap binding and shoulder strap back panel

Shoulder strap padded by EVA 10 mm

Front and back panel padded by PE Sponge 3mm and 5 mm respectively

Nylon 210d PU for inside lining for main compartment and inside flaps

Nylon webbing

Hardware

Quickly backfills up to 3 CamelBak® Hydration Systems at a time

Drinking tubes connect via two HydroLink™ Spigots located at the base of the SquadBak™ and the large 1/2 in diameter fillhose refills one additional reservoir via the fillport

Bag be easily filled using the massive OMEGA™ fillport or by backfilling through the 1/2 in diameter fillhose

Collapses for convenient storage when your mission is over and the system is empty

HydroLink™ modular attachment system with reservoir shut-off valve

Insulated Neoprene tube cover keeps liquids cool or warm while protecting from harmful UV rays

Ergonomic fill handle for easy filling and transport

Hook-and-loop strap management

3 hang /drag handles with S/ R buckles make for easy transport and hanging

S/ R buckles for quick release from shoulder harness

10 mm EVA foam used on Floating Shoulder Harness design that bag be stored away in pocket on back panel when not in transport

CIMA Sport's WXP™ Hydration System

Material

Exterior: Tough abrasion resistant 1000D Cordura® Nylon IRR.

Insulation: 5 mm closed cell PE.

Liner: 210d Nylon

Straps: Heavy Duty PP.

Buckles: Super tough Nylon

Hardware

Carrying Handles/ Hangers- one on the back and two on top of the bag.

External fill port with integral refill handle- Delivers fast and easy refills on-the –move with no spills.

2 Side Pouches – for keeping the tubes protected.

Multiple MOLLE attachments

Figure 3: WXP™ Hydration System

3. Test Methods

3.1 Setup and Instrumentation

For testing, see Table 1, a Data Acquisition System (DAS) was used to measure the ambient temperature and water core temperature. Type-K 24 gage, thermocouples was used in conjunction with the DAS to monitor and record the thermal profile. Setup and instrumentation is shown in Figure 2.

FIGURE 4: Setup and Instrumentation

Instruments/Materials	Model Number	Serial Number
Panasonic Video Camera		
HP Agilent Data Logger	39470A	
Thermocouples, 24 Gage	Type-K	
YSI Professional Plus		

TABLE 1: Test Equipment and Materials

3.2 Thermostat Calibration

4.0 Performance Testing

4.1 Performance Testing -Inspection

Prior to testing, it was ensured that the plastic/materials used for the water bags meet the requirements of 21 CFR – Food and Drugs: Indirect Food Additives: Polymers, Subpart B, Part 177, Chapter I, Title 21, Code for Federal Requirements for Contact with Food.

4.1.1 Test Objective

The objectives of this test was:

a. To determine if the water bag was complete, undamaged, operating properly, and ready for testing.

b. To correct any significant defects or shipping damages prior to test initiation.

c. To determine the weights of the water bag.

d. To record all serial and model numbers and other pertinent data.

4.1.2 Test Criterion

The male and female threads on the water bag shall be fully formed and free from flash or thread misalignment at the parting line. The finished water bag shall not leak when tested.

The exterior surfaces of the water bags and the cap/s assembly shall have a smooth and lusterless finish throughout. All surfaces shall be free of dirt, dust and foreign matter inclusion. The inside of the cap assembly, including threaded portion, shall posses a uniformly high luster throughout as imparted by a polished die. The water bag shall be clean, void of plastic shavings, and free from flash, bubbles, cuts, tears, holes, burns, breaks, cracks, pins, warpage, blisters, scratches or any weld marks or sink marks, expect the mold parting lines are acceptable.

4.1.3 Test Procedures/Test Findings

a. Upon arrival of the test item, a visual inspection and an operational checkout was performed to ensure that no damage occurred during shipment. A complete inventory was recorded.

b. General view photographs of the test item were taken. Each component of the system was examined visually for defects or evidence of damage that may have occurred during shipping and handling. No discrepancies were found on the HSCWB.

4.2 Performance Testing -Leakage Testing

4.2.1 Test Objectives

To test the water bag's ability to hold 5 gallons or more of water without any leakage.

4.2.2 Test Criterion

The water bag can withstand, without any damage, degradation to it, and without any detrimental effect on its ability to hold at least 5 gallons of water. To determine compliance, any evidence of leaking or presence of moisture shall constitute failure.

4.2.3 Test Procedures/Test Findings

The water bags were filled water at 73°F +/-3°F. The cap was screwed down and tightened and the water bag was allowed to remain on its bottom for 10 minutes and examined. The water bag was rotated 180° with the cap facing down for not less than 30 minutes, and examined for any leakage or presence of moisture. No water leakage was noticed for the water bags.

4.3 Performance Testing -Air Drop Test

4.3.1 Test Objective

To test the water bag's ability to hold 5 gallons or more of water without any leakage after 35 feet air drop on concrete/sand.

4.3.2 Test Criterion

The water bag can withstand multiple drops of 35 feet, without any damage, degradation to it, and without any detrimental effect on its ability to hold at least 5 gallons of water. To determine compliance, any evidence of leaking or presence of moisture shall constitute failure.

4.3.3 Test Procedures/Test Results

The water bag was filled with 5 or more gallons of water at 73°F+/-3°F. The water bag was dropped from a height of 35 feet on a horizontal surface (including asphalt and sand) to determine compliance. The water bag was then examined for leakage. Repeat drop tests 25 times and document each drop and inspect for leakage and for any component/s failure after each drop. If the water bag survives 25 drops from 35 feet with full water load (+5 gallons) the water bag is in compliance with the air drop test.

Figure 5: Air Drop Testing of HSCWB

Figure 6: Air Drop Testing of HSCWB/Video Snapshot

4.4 Performance Testing-Ambient Testing

4.4.1 Test Objective

The objective of this test is to ensure the water bag's components can hold water at ambient temperatures of 125°F and -10°F, without any issues.

4.4.2 Test Criterion

Any visible evidence of cracks or cracking on cap/s, leakage of the water shall constitute failure of this test.

4.4.3 Test Procedures/Test Findings

The interior of chambers were instrumented with three type-K thermocouples to record temperatures. All data were recorded every 5 min during soak periods and every minute during operation. The climatic chamber's ambient temperature was allowed to reach 115°F. At this time, water at was poured into the HSCWB. The test was run for 24 h while the data logging system took temperature samples at various points of interest every 2 minutes.

At the completion of the 24-hr soak period, the HSCWB was inspected for damage or deformity resulting from exposure to high temperature. All fabric, drink tubes, and caps/covers did not show any signs of deterioration. No discrepancies were found.

Upon completing the cold soak, the chamber temperature was raised to -10°F. Once the chamber reached the target temperature, the HSCWB was soaked for 24 hrs. The HSCWB was visually inspected for any damage or deformity. All components, etc., were operated to verify proper operation. No discrepancies were found. No loss of resiliency of gaskets, discoloring, cracking, bulging or failure to hold/operate was observed.

4.5 Performance Testing-Water Potability Test

4.5.1 Test Objective

The objective of this is to ensure the potability of the water is not affected in any way, by storing water in the water bag.

4.5.2 Test Criterion

Water potability is evaluated by measuring chlorine residual, the total colifoms and the dissolved oxygen. Coliform bacteria are reliable indicator organisms for testing water quality because they travel with disease producing organisms. See figure 7 for acceptable parameters. The presence of coliform bacteria in water usually indicates that the water is unsuitable for drinking. Dissolved oxygen monitoring is important in the determination of the quality of drinking water. Low dissolved oxygen levels usually indicate serious pollution. Chlorine residual over 1.0 mg/L is too high and leaves a bad taste in the water. These parameters were derived from TB MED 577 (DOD and international military potable field water quality standards).

Color (Color Unit)	Odor (Threshold odor Number)	pH	TDS (mg/L)
Turbidity (NTU)	**Arsenic (mg/L)**	**Chloride (mg/L)**	**Sulfate (mg/L)**

Table II. Water Quality Testing Parameters

4.5.3 Test Procedure/Test Findings

The water in these water bags were examined for the above mentioned parameters immediately after 24 hours at 125°F. Table II provided the maximum contaminant levels recommended by DoD Tri- Service regulations. The water parameters levels were documented after the HSCWB was exposed to 24 hrs at 12°F and compared with the DoD Tri- Service regulations. Data suggests the water quality does not get affected by storing the water in the HSCWB even after 24 hrs at high ambient temperatures.

Figure 7: Coliform Bacteria

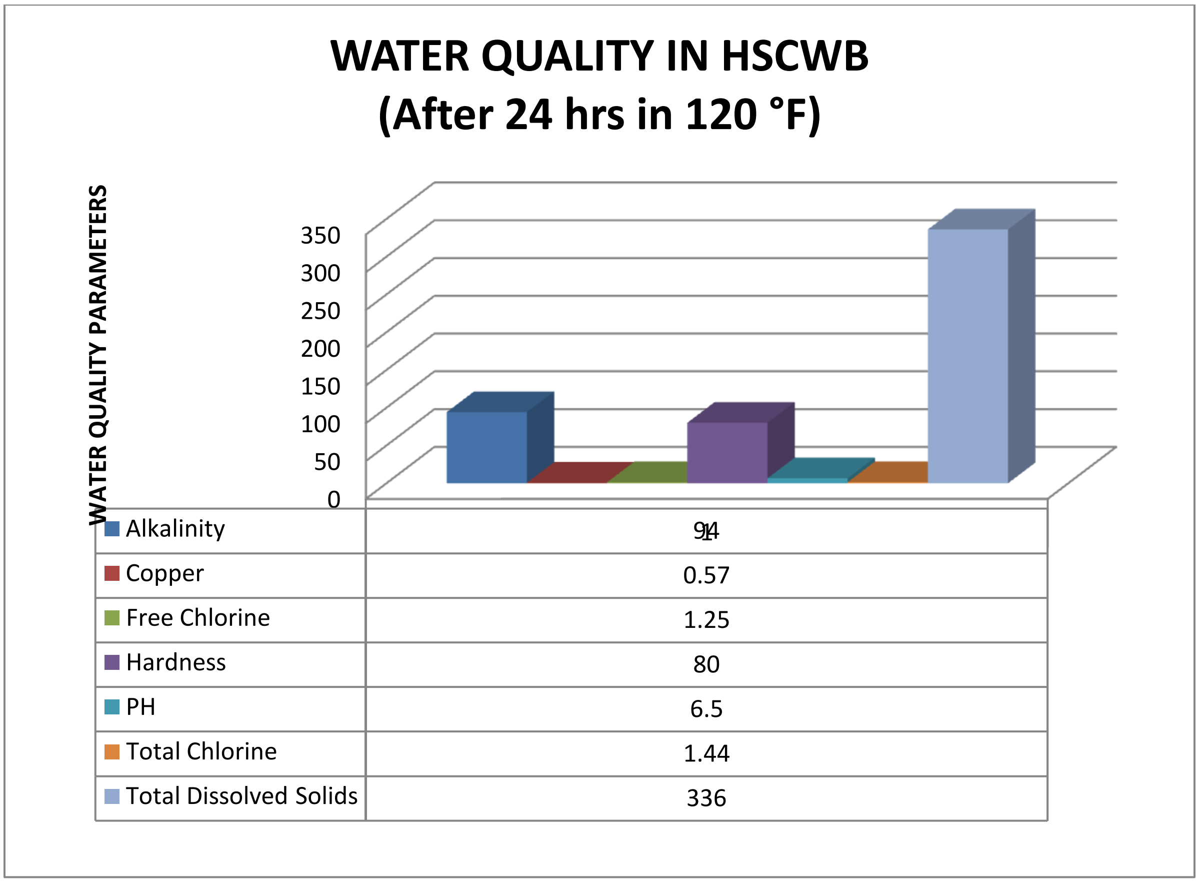


Chart 1: Water Quality Parameters

Parameters	**DoD TRI-Service Standards**	**Testing Results,** After 24 hrs @ 125° F
Physical Properties		
Color (color unit)	15	Not Detected
Odor (Threshold Odor Number)	3	No Odor
pH	5-9	6.5
TDS (mg/L)	1000	336
Turbidity (NTU)	1	1.2
Chloride (mg/L)	600	160
Sulfate (mg/L)	100	17
Coliform (#/100ml)	0	1

Table II. DoD Tri-Services Regulations

4.6 Performance Testing-Taber Abrasion Testing

4.6.1 Test Objective

The objective is to test the bag's ability to withstand abrasion in the event it is dragged by a HMMVW/military vehicle on an asphalt road.

4.6.2 Test Criterion

The haze measurements and initial and final weight losses shall be a metric for the bag's ability to withstand abrasion.

4.6.3 Test Procedures/Test Findings

The ASTM D3389 - 05 Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader) standard shall be used as guideline to conduct this test. This test method is to ensure the bag's ability to withstand abrasion in the event it is dragged by a HMMVW/military vehicle on an asphalt road.

This test method covers the determination of the resistance to abrasion of fabrics coated with rubber or plastics. Resistance to abrasion is defined as the ability of a material to withstand mechanical action such as rubbing scrapping, or erosion. Abrasion bag be difficult to compare but haze variation or weight loss bag be evaluated.

The haze or original weight of test specimen is measured. The test specimen is then placed on the abrasion tester. A 1000-gram load is placed on top of the abrader wheel (H-22) and allowed to spin for a 1000 revolutions. A haze measurement or final weight is taken. Test data shall be in Mass Loss per revolution.

See attachment for Test Report.

4.7 Final Inspection

4.7.1 Test Objective

The objective of this test was to account for and document the condition of all test items at the completion of testing.

4.7.2 Test Procedures/Test Findings

An inventory was performed, and a visual inspection of the HSCWB was conducted. No damage/fabric breakdown/components were found.

5. Conclusions

Lack of water distribution capability for the Small Combat Unit in austere locations is straining sustainment of small outposts and placing Soldiers in near critical situations due to shortages of potable water. Based upon testing conducted under the CPI program the HSCWB will allow the war fighter to safely deliver water to austere locations, irrespective of ambient temperatures, surface locations without the possibility of landing to off load without detrimental effect on the water quality. A follow-on limited user evaluation in a field environment is recommended to ensure the HSCWB can be fully evaluated for meeting Warfighter needs.

NOTES

Page intentionally left blank

Bibliography

1. *Military Specification: Bag, Water, Military: Plastic, 5-Gallon Capacity.* 1993. MIL-C-43613D.

2. *Standard Practice for Conditioning and Testing Textiles.* ASTM D1776 - 08.

3. *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test.* ASTM D5034 -08.

4. *National Sanitation Foundation (NSF)* . s.l. : NSF, 2008. 61.

SYSTEMS EQUIPMENT AND ENGINEERING TEAM
DOD-COMBAT FEEDING DIRECTORATE
US ARMY NATICK SOLDIER RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Multi-Fueled Stove Performance Testing

Test & Evaluation of a Multi-Fueled Stove for Squad Field Feeding

Ben Williams
7/26/2011

G

Table of Contents

List of Figures

List of Tables

Preface

This report describes an evaluation of the food preparation performance and operational performance of a multi-fueled burner known as the Volcano II collapsible stove. The Volcano II is capable of performing most cooking functions (boil, grill, shallow pan fry, and bake) using propane gas, wood, or coal. The Volcano II is also capable of collapsing into a 5 in. thick disc, 17.5” in diameter, thereby maximizing the pack-out space necessary for transport. This testing is being conducted to evaluate this novel cooking platform based on its performance and relevance for field feeding at a squad sized level (8-13 men).

OPERATIONAL PERFORMANCE OF A MULTI-FUELED STOVE: VOLCANO II Collapsible Stove

1. Introduction

Field feeding in austere combat environments where limited resources are available for fuel, transport, or food is a challenge, but crucial to providing the Warfighter with consumable water and freshly prepared food. To meet this challenge and provide the Warfighter with highly operationally available equipment, it is necessary to investigate and develop field feeding equipment that is flexible, efficient, light-weight, relatively small, and multi-fueled.

This report describes NSRDEC evaluation, conducted from June 2011 through August 2011, of a product (The Volcano II) which may be capable of meeting the challenging needs posed by an austere combat environment.

Implementing such a flexible and efficient stove for squad level use would drastically reduce the burden and urgency on the logistical demand needed to provide Warfighters with food in austere operational scenarios. This reduction in burden and urgency on the food-related logistical demands of a squad can be realized by a few factors:

1) A multi-fueled stove requires fewer re-supplies of fuel allowing the user to leverage local fuel sources such as the local wood supply, coal, or any fuel source that is safely combusted.
2) A more capable stove (such as the Volcano II) allows for the user to perform many more cooking functions; so while a normal camp stove allows for boiling and limited grilling, the Volcano II allows the user to grill, boil, braise, shallow pan fry, and bake. This increase in cooking method capabilities allows the user to leverage many more types of food for personal consumption, allowing the user to leverage local, wild, or fresh food sources (A-Rations, etc) which would have been difficult or impossible to safely prepare with currently fielded camping stoves.

1.2 Tests Performed

Ten performance tests were performed in 3 categories: Food Preparation Performance Tests, Operational Performance Tests, and Durability Performance Tests. A specific list of the tests performed and the fuel used during each test can be viewed in Table 1 below. A more detailed description of each test can be found in section 2 of this report.

Table 1: Volcano II Collapsible Performance Testing

Volcano II Collapsible Performance Testing				
	Fuel Used			
Test Conducted	Gas	Coal	Wood	Performance Test Category
Boil	X	X	X	Food Preparation Performance Tests
Grill	X	X	X	
Shallow Pan Fry	X	X	X	
Oven	X	X	X	
Throughput	X	NA	NA	
Drop	NA	NA	NA	Durability Performance Tests
Crush	NA	NA	NA	
Wind	X	X	X	Operational Performance Tests
Water Resistance	X	X	X	
Heat Signature	X	X	X	

1.3 Item Descriptions

1.3.1 Volcano II Collapsible Stove

The Volcano II Collapsible Stove is a highly versatile multi-fueled stove capable of grilling (Figure 1), shallow pan frying (Figure 2), boiling (Figure 3), and baking with an additional heat resistant fabric cover/lid (Figure 4). The Volcano II can perform all of these cooking functions using either propane gas, wood, or coal as the input fuel (Figure 5). The stove is also capable of collapsing down to a disk with a thickness of 5 in. and a diameter of 17.5" (Figure 6). The total weight of the Volcano II system with all accessories is approximately 20 lbs. The Volcano II system is constructed of heavy gauge steel, requiring washing of only the cooking grates and disposal of any ash remnants. The stove also incorporates a patented adjustable vent system; allowing the user to adjust the air flow feeding the fuel's combustion. This optimal adjustment in the air to fuel ratio allows the stove to perform at higher efficiencies in various scenarios and conditions than standard camp stoves when using either of the three specified fuel sources (gas, wood, coal).

Figure 1. Volcano II Grilling

Figure 2. Volcano II Shallow Pan Frying

Figure 3. Volcano II Boiling

Figure 4. Volcano II Baking Lid

Figure 5. Volcano Multi-Fuel

Figure 6. Volcano II Collapsed

2. Methods and Procedures

Ten different performance tests were conducted to determine the Volcano II's food preparation performance, durability, and operational performance in relevance to austere operational scenarios.

2.1 Food Preparation Performance: Boil Test

The boil test was conducted to determine the stove's ability to transfer heat to water contained within a covered vessel.

The boil test was conducted by placing an 11 quart aluminum stock pot on the stove with approximately 2.5 gallons of tap water contained within the stock pot at an initial temperature of 80°F ±5°F. The stock pot was then covered with a lid and the stove was lit. When the stove was lit with charcoal, 4 lbs of charcoal was used and the fuel source was allowed to burn for 15 minutes before testing. When the stove was lit with propane or wood, the fuel source was allowed to burn for 5 minutes before testing. When testing with wood, approximately 3 lbs of wood was used. The pot was then placed on the stove on either the top or bottom grate, the data logging unit was turned on, and the water was allowed to reach a temperature of 212°F or remain on the stove for one hour, whichever came first.

At the conclusion of the test, the time it took to raise the water temperature from its start point to 212°F was recorded. If the water did not reach 212°F in 1 hour, its maximum temperature was recorded. During this test the temperature of the water was monitored using Graphtec GL200A data logging system.

This test was performed a total of six times; once with each type of fuel (propane, charcoal, and wood), and once with each type of fuel while utilizing the Volcano II baking lid. The baking lid was used during these tests to determine the baking lid's effectiveness at increasing the heat transfer rate to the contained water within the stock pot due to the lid's insulation properties.

Table 2: Food Preparation Performance: Boil Test-With and Without Baking Lid

Boil Test:Propane	**Boil Test: Charcoal and Wood**
	
Boil Test With Lid: Propane	**Boil Test With Lid: Charcoal and Wood**
	

2.2 Food Preparation Performance: Grill Test

The grill test was conducted to determine the Volcano II's effectiveness at cooking food items which would normally be grilled, i.e., burgers, steaks, hot dogs, etc. These food items or items like them are commonly found throughout the world as well as in the UGR-A menu.

The grill test was conducted by lighting the grill in an outdoor environment with propane, charcoal, and wood. When the stove was lit with charcoal, 4 lbs of charcoal was used and the fuel source was allowed to burn for 15 minutes before testing. When the stove was lit with propane or wood, the fuel source

was allowed to burn for 5 minutes before testing. When testing with wood, approximately 3 lbs of wood was used. After the initial warm up, 1 burger, 1 steak, and 1 hot dog were placed on the grill. Their internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached the recommended levels represented in Table 3 below. The physical weight of each food item was also recorded and can be viewed in Table 3 below.

Table 3: Food Items for Food Preparation Performance Grill Test

Food Item	Weight	Recommended Internal Temperature
Burger	151 g	160°F
Chicken	136 g	165°F
Hot Dog	57 g	160°F

2.3 Food Preparation Performance: Shallow Pan Fry Test

The shallow pan fry test was conducted to determine the Volcano II's effectiveness at cooking food items which would normally be shallow pan fried, braised, or griddled, i.e., chicken fried steak, eggs, stir-fry, etc. Shallow pan frying and stir-frying food items is a common practice throughout the world, and there are multiple food items included in the UGR-A menu which can or are required to be shallow pan fried.

The shallow pan fry test was conducted by removing the Volcano II top grill and lighting the grill in an outdoor environment with propane, charcoal, and wood. When the stove was lit with charcoal, 4 lbs of charcoal was used and the fuel source was allowed to burn for 15 minutes before testing. When the stove was lit with propane or wood, the fuel source was allowed to burn for 5 minutes before testing. When testing with wood, approximately 3 lbs of wood was used. After the initial warm up, a 15 inch non-stick skillet was placed into the top of the Volcano II and approximately 32 oz of egg beaters egg mix was poured into the skillet. The time necessary to cook the egg mix to a consumable consistency was then noted.

Picture of the test setup in its propane configuration can be seen below in Figure 7.

Figure 7. Test Setup-Propane Shallow Pan Fry Test Configuration

2.4 Food Preparation Performance: Baking Test

The Baking test was conducted to determine the Volcano II's effectiveness at baking simple food items which are normally baked, i.e., potatoes, fries, rolls. While the Volcano II does not have the capability to precisely regulate the heat it outputs, as for the purposes of baking a cake, the Volcano is capable of baking food items which require a crispy outer layer or relatively higher baking temperatures in their cooking processes.

The Baking test was conducted by placing the Volcano II top grate onto the stove, lighting the grill in an outdoor environment (with propane, charcoal, and wood). When the stove was lit with charcoal, 4 lbs of charcoal was used and the fuel source was allowed to burn for 15 minutes before testing. When the stove was lit with propane or wood, the fuel source was allowed to burn for 5 minutes before testing. When testing with wood, approximately 3 lbs of wood was used. After the initial warm up, 4 potatoes were placed onto the Volcano II top grate wrapped in aluminum foil and the Volcano II baking lid was placed over the stove.

The temperature of the potatoes being cooking was monitored using a Graphtec GL200A data logging system, and the time it took for all potatoes' internal temperatures to reach 195°F was recorded.

2.5 Food Preparation Performance: Throughput Test

The Throughput test was conducted to determine the Volcano II's throughput capacity in relation to cooking a meal for approximately 8-13 people (squad sized). This meal resembled a stereotypical barbeque; consisting of chili, chicken, hamburgers, and hot dogs.

The Throughput test was conducted by placing the Volcano II top grate onto the stove and lighting the grill in an outdoor environment with propane. The grill was then allowed to pre-heat for approximately 5 minutes. After the initial warm up, like food items (i.e., chili, chicken, hamburgers, hot dogs) were loaded onto the grill in separate loads until the grill's cooking space was completely utilized. The chili was cooked in an 11 qt NSF stock pot with a lid. The Volcano II's baking lid was also used when cooking the chili in order to decrease the chili's cook time.

An NSF certified meat thermometer was used during the throughput test to determine when the food items reached their proper temperature. The food items cooked during the Throughput test, their individual weights, and the recommended internal temperatures that each food item was cooked to can be seen in Table 4 below.

Table 4. Food Items for Throughput Test

Food Item	Weight	Recommended Internal Temperature
Burger	151 g (EA)	160°F
Chicken	136 g (EA)	165°F
Hot Dog	57 g (EA)	160°F
Chili	15 oz (EA)	180°F

2.6 Durability Performance: Drop Test

The drop test was conducted to determine the Volcano II's ability to withstand external shock forces resulting from expected rough handling.

The drop test was conducted by dropping the stove from a height of 4 ft onto a concrete surface a total of 10 times. During the drop tests the stove was in its collapsed configuration.

After the test, any damage or loss in functionality will be noted.

2.7 Durability Performance: Crush Test

The crush test was conducted to determine the Volcano II's ability to withstand external forces, specifically related to scenarios encounter during transport where Warfighters may inadvertently step on the stove while packed away amongst other gear.

This test was conducted by applying a 250 lb force to the stove in its collapsed and operational configuration for approximately 1 minute each. This force was applied by placing a piece of sheet metal on top of the stove and placing approximately 5 military issue water cans full of water on the sheet metal with a total combined weight of 250 lbs.

2.8 Operational Performance: Wind Resistance Test

The wind resistance test was conducted to determine the Volcano II's capability to operate in windy conditions.

The wind resistance test was conducted by lighting the Volcano II stove in an outdoor environment with propane, charcoal, and wood. The stove was then allowed to burn for approximately 15 minutes if running on charcoal or wood. After the initial 15 minutes of burn time (excluding propane), the stove was subjected to 1200 CFM of a moving air current for 10 minutes. This moving air current was generated by a Fasco-Super Cat 1200XL Blower at a distance of approximately 6 ft. During this time the blower output duct was aimed directly at the stove. Any variation in the stoves flame quality or ability to stay lit was noted. This test was then conducted with the Volcano II baking lid over the stove in order to determine the lid's ability to increase the stove's performance under blowing wind conditions.

If the stove's flame was extinguished, the time to re-light the stove under the blowing wind conditions was noted.

A picture of the wind resistance test procedure setup can be seen below in Figure 8.

Figure 8. Wind Test Procedure Setup

2.9 Operational Performance: Water Resistance Test

The water resistance test was conducted to determine the Volcano II's water resistance in reference to its ability to operate in raining conditions.

The water resistance test was conducted by lighting the stove in an outdoor environment (with propane, charcoal, and wood). The stove was then allowed to run for approximately 15 minutes if running on charcoal or wood. After the 15 minutes of initial burn time (excluding propane), water at a flow rate of .5 gallons per minute was showered over the stove for approximately 5 minutes from a height of approximately 6 ft by using a standard shower nozzle attached to a standard garden hose which was set on the "mist" setting. This test was conducted with the Volcano II baking lid over the stove in order to determine the lid's ability to increase the stove's performance under heavy rain conditions. This test configuration can be seen below in Figure 9.

Figure 9. Rain resistance test with baking lid

The time it took the water to extinguish the stoves' flames was recorded. If the stove's flame was extinguished, the time it took to re-light the stove (void of rain during the re-lighting process) was recorded.

2.10 Operational Performance: Heat Signature Test

The heat signature test was conducted to determine the Volcano II's heat signature and the capability of the Volcano II baking lid to reduce the stove's heat signature.

The heat signature test was conducted by lighting the stove in an outdoor environment (with propane, charcoal, and wood). The stove was then left to run for approximately 10 minutes. After 10 minutes of run time, a thermal image of the stove was taken at approximately a 10 ft distance and then a 5 ft distance. The stove was then covered with the Volcano II baking lid and left to run for an additional 10

minutes. After the additional 10 minutes of covered run time, a thermal image was taken of the covered stove at a distance of approximately 10 ft and 5 ft.

3. Results and Discussion

3.1 Food Preparation Performance: Boil Test

3.1.1 Food Preparation Performance: Propane Boil Test-Top Grate-No Baking Lid

During this test, the stock pot was placed on the top grate. This test was conducted to determine the difference in heat transfer when compared to putting the stock pot on the bottom grate, which is closer to the flame.

As it can be seen in Figure 10 below, the 2.5 gallons contained within the stock pot took a total of 64.5 minutes to reach 212°F, which is a difference of 128.3°F or an increase of 2°F/min.

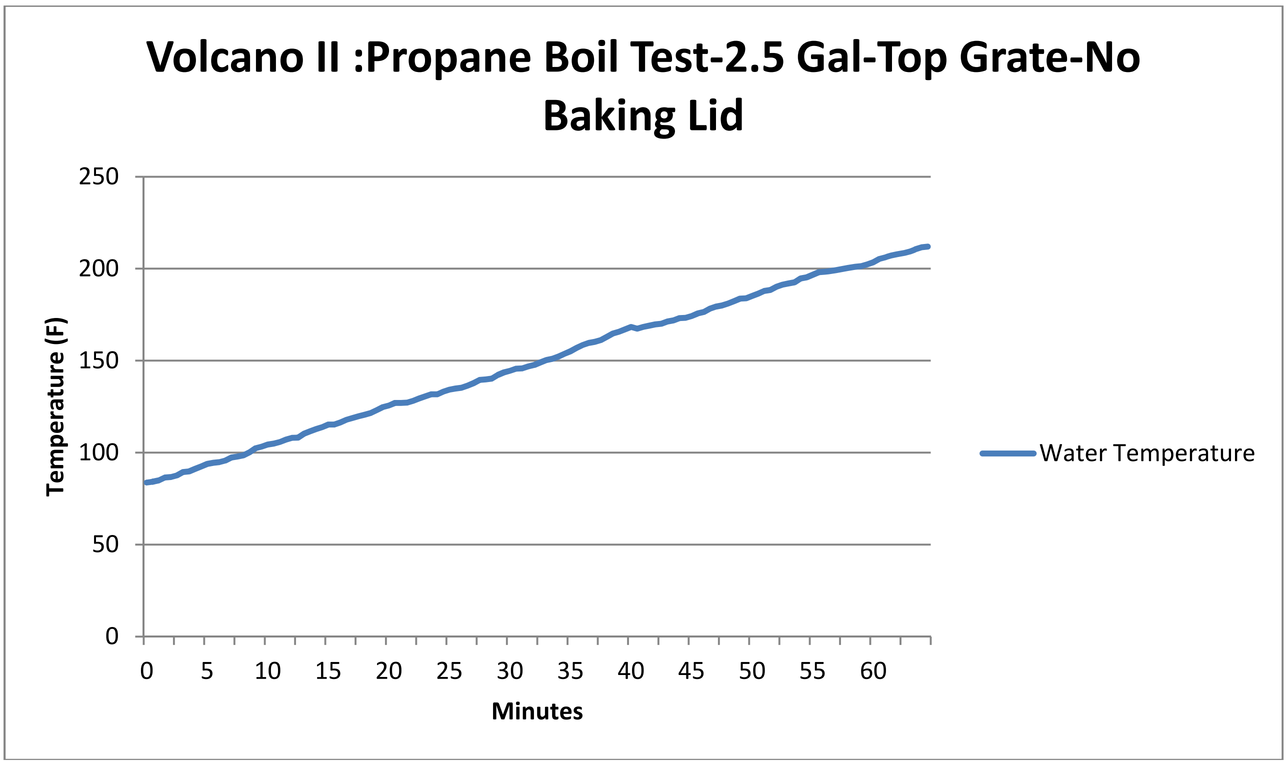


Figure 10. Propane Boil Test-2.5 Gal-Top Grate-No Baking Lid

A picture showing the setup of the above performed test can be seen in Figure 11 below.

Figure 11. Propane Boil Test-2.5 Gal-Top Grate-No Baking Lid

3.1.2 Food Preparation Performance: Propane Boil Test-Top Grate-With Baking Lid

During this test, the stock pot was placed on the top grate and the baking lid was placed over the stock pot to attempt to retain as much heat as possible, thereby increasing the heat transfer performance of the stove. This test was conducted to determine the difference in heat transfer when compared to putting the stock pot on the top grate with no baking lid, as well as putting the stock pot on the bottom grate in a covered and uncovered state.

As it can be seen in Figure 12 Figure 10 below, the 2.5 gallons contained within the stock pot took a total of 44 minutes to reach 212°F, which is a difference of 131.8°F or an average increase of 3°F/min.

This is a heat up rate increase of 1°F/min over the previously conducted test where the stock pot was uncovered.

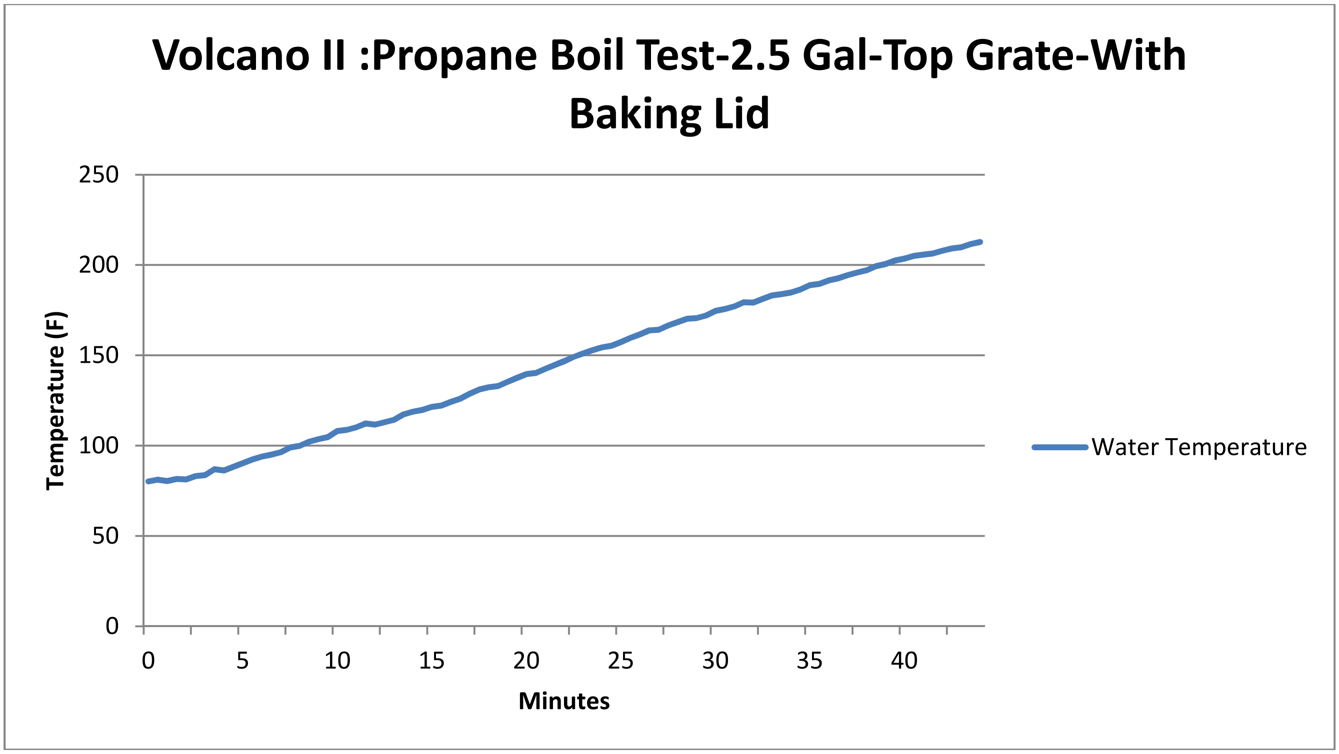


Figure 12. Propane Boil Test-2.5 Gal-Top Grate-With Baking Lid

A picture showing the setup of the above performed test can be seen in Figure 13 below.

Figure 13. Propane Boil Test-Top Grate-With Baking Lid

3.1.3 Food Preparation Performance: Propane Boil Test-Bottom Grate-With Baking Lid

During this test, the stock pot was placed on the bottom grate and the baking lid was placed over the stock pot to attempt to retain as much heat as possible, thereby increasing the heat transfer performance of the stove. This test was conducted to determine the difference in heat transfer when compared to putting the stock pot on the top grate with and without the baking lid. This test was performed only with the baking lid on, as using the baking lid was proven by the previous testing to drastically enhance the performance of the stove; deeming it unnecessary to conduct this test without the baking lid.

As it can be seen in Figure 14 below, the 2.5 gallons contained within the stock pot took a total of 24 minutes to reach 212°F, which is a difference of 131°F or an average increase of 5.45°F/min.

This is a heat up rate increase of 2.45°F/min over the previously conducted test where the stock pot was covered on the top grate.

From this testing it can be concluded that placing the stock pot on the bottom grate in its covered configuration drastically increases the heat transfer performance of the stove. A time of 24 minutes to boil all of the water necessary for a meal is also highly acceptable when compared to standard cooking practices performed in larger military kitchens, where it is not uncommon to allot 45 minutes of time for boiling all of the hot water necessary for a meal.

The recorded boil time of 24 minutes also equates to a net efficiency of 45% when factoring the flow rate of the propane cylinder at 15,000 Btu/hr. This recorded efficiency is in-line with commercial natural gas food equipment, which usually operates with an efficiency between 40-50%.

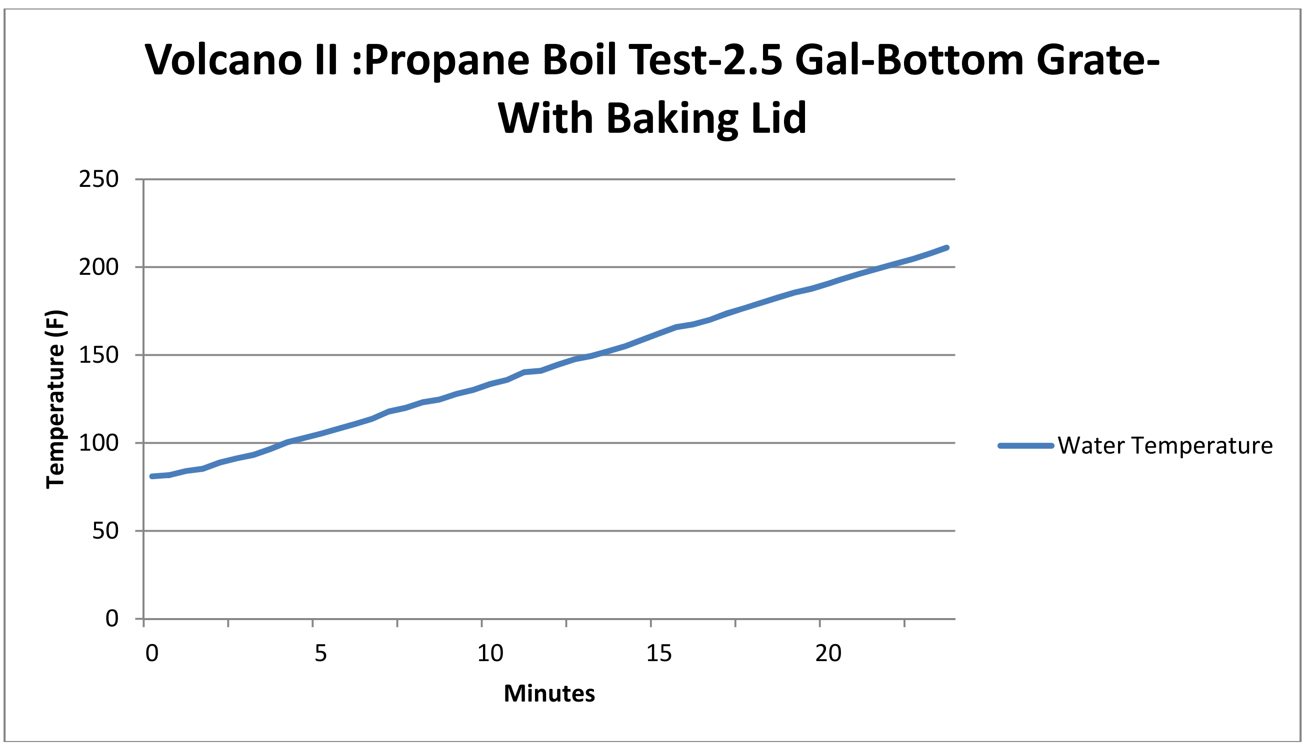


Figure 14. Propane Boil Test-2.5 Gal-Bottom Grate-With Baking Lid

A picture showing the setup of the above performed test can be seen in Figure 13 below. The cover was taken off in the left picture to show the difference in height between the top and bottom grates; with the bottom grate being closer to the flame.

Figure 15. Propane Boil Test-2.5 Gal-Bottom Grate-With Baking Lid

3.1.4 Food Preparation Performance: Charcoal Boil Test-Bottom Grate-With Baking Lid

During this test, the stock pot was placed on the bottom grate and the baking lid was placed over the stock pot to attempt to retain as much heat as possible, thereby increasing the heat transfer performance of the stove. This test was conducted to determine the difference in heat transfer when compared to using propane or wood. This test was performed only on the bottom grate with the baking lid on, as using the baking lid with the stock pot on the bottom grate was proven by the propane testing to drastically enhance the performance of the stove, deeming it unnecessary to conduct this test in any other configuration.

As it can be seen in Figure 16Figure 10 below, the 2.5 gallons contained within the stock pot took a total of 58 minutes to reach 212°F, which is a difference of 128.5°F from the starting temperature of 83.5°F, or an average increase of 2.21°F/min.

Therefore, it can be concluded from the testing that using charcoal with the stock pot on the bottom grate with the baking lid to boil water is comparable to boiling water with propane when the stock pot is placed on the top grate with no baking lid.

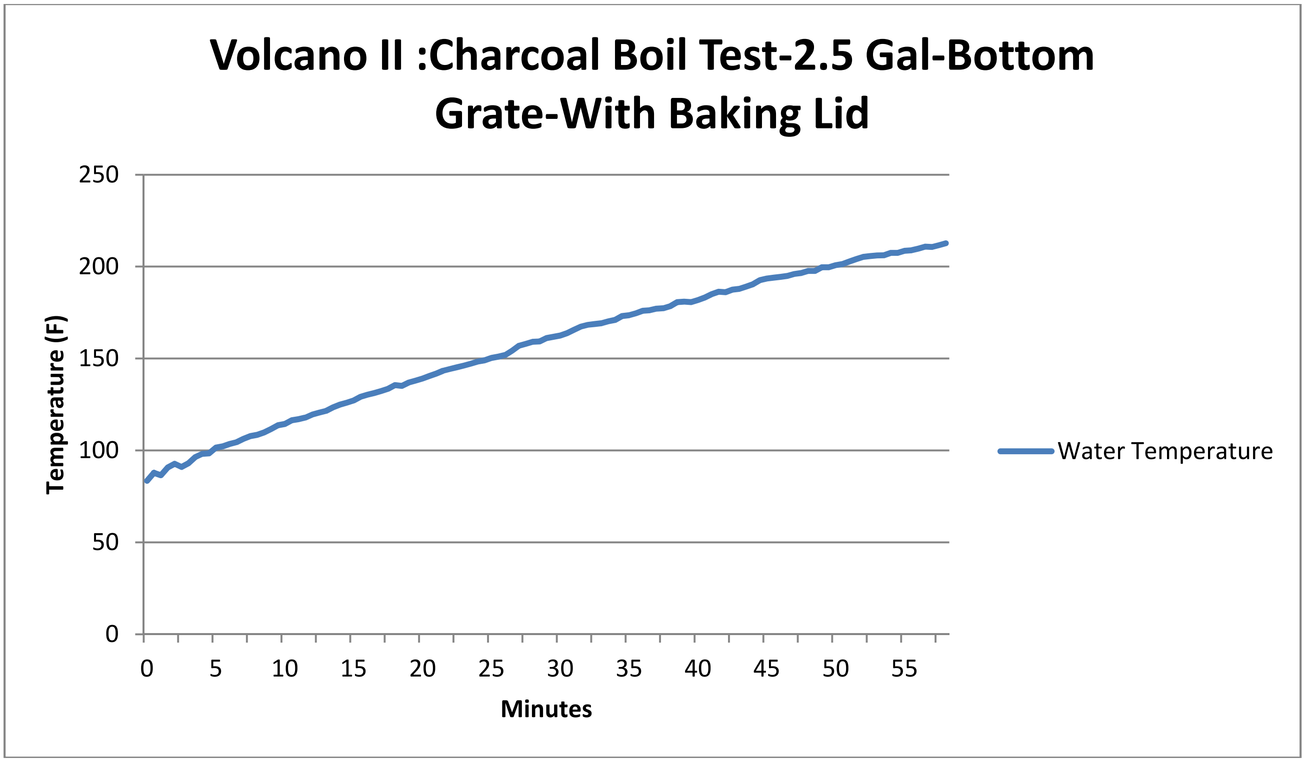


Figure 16. Charcoal Boil Test-2.5 Gal-Bottom Grate-With Baking Lid

3.1.5 Food Preparation Performance: Wood Boil Test-Bottom Grate-With Baking Lid

During this test, the stock pot was placed on the bottom grate and the baking lid was placed over the stock pot to attempt to retain as much heat as possible, thereby increasing the heat transfer performance of the stove. This test was conducted to determine the difference in heat transfer when compared to using propane or charcoal. This test was performed only on the bottom grate with the baking lid on, as using the baking lid with the stock pot on the bottom grate was proven by the propane testing to drastically enhance the performance of the stove, deeming it unnecessary to conduct this test in any other configuration.

As it can be seen in Figure 17Figure 10 below, the 2.5 gallons contained within the stock pot took a total of 38 minutes to reach 212°F, which is a difference of 131.2°F from the starting temperature of 80.8°F, or an average increase of 3.45°F/min.

Therefore, it can be concluded from the testing that using wood with the stock pot on the bottom grate with the baking lid to boil water is slightly faster than boiling water with propane when the stock pot is placed on the top grate with the baking lid.

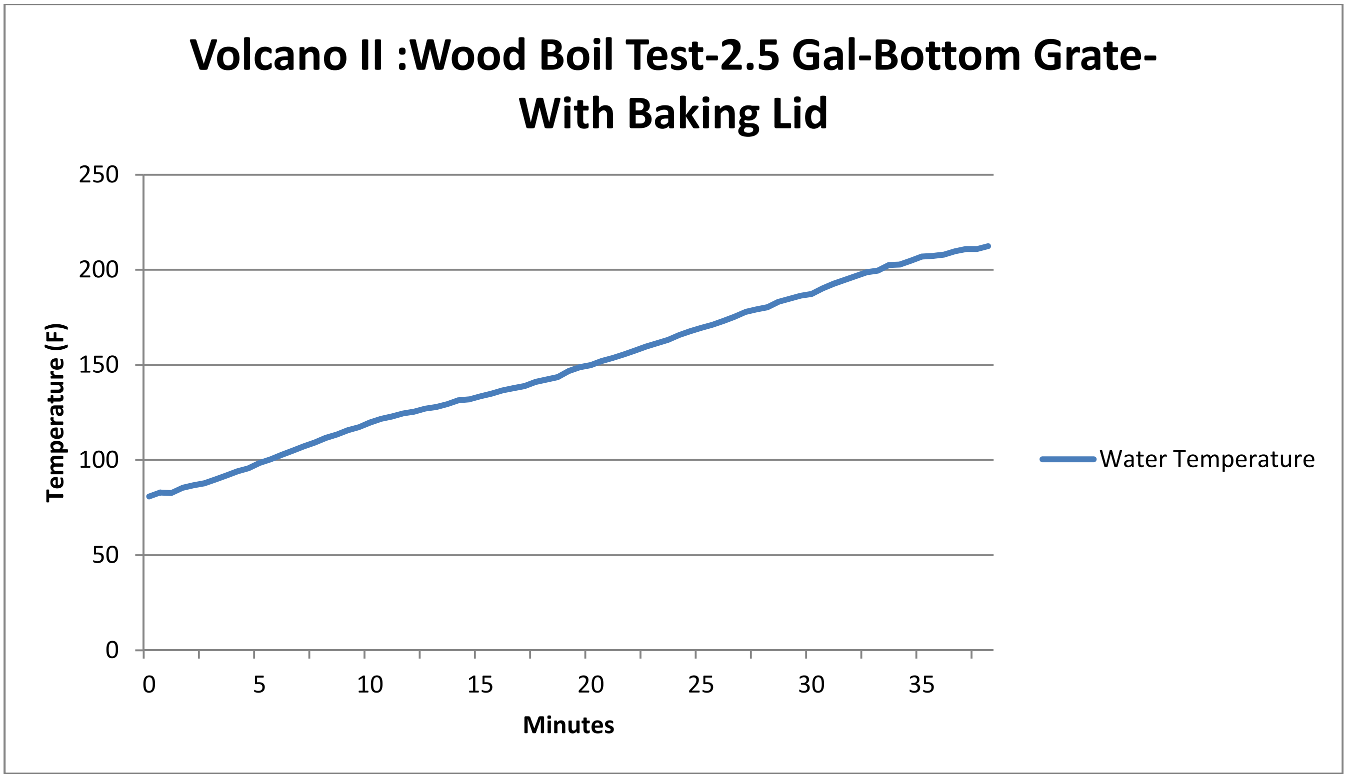


Figure 17. Wood Boil Test-Bottom Grate-With Baking Lid

3.2 Food Preparation Performance: Grill Test

3.2.1 Food Preparation Performance: Grill Test:-Charcoal

During this test the grill was lit in an outdoor environment with charcoal. After the 15 minute initial warm up, 1 burger, 1 steak, and 1 hot dog were placed on the grill. Their internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached the recommended levels represented in Table 3.

As it can be seen in Figure 18 below, the chicken was finished cooking in approximately 7.2 minutes while the hot dog and hamburger took approximately 9.2 minutes to cook. The chicken and hamburger were also flipped at approximately 6.2 and 5.5 minutes respectively, causing a flare-up which inadvertently made the hot dog temperature rise and fall drastically. These results are also summarized in Table 5.

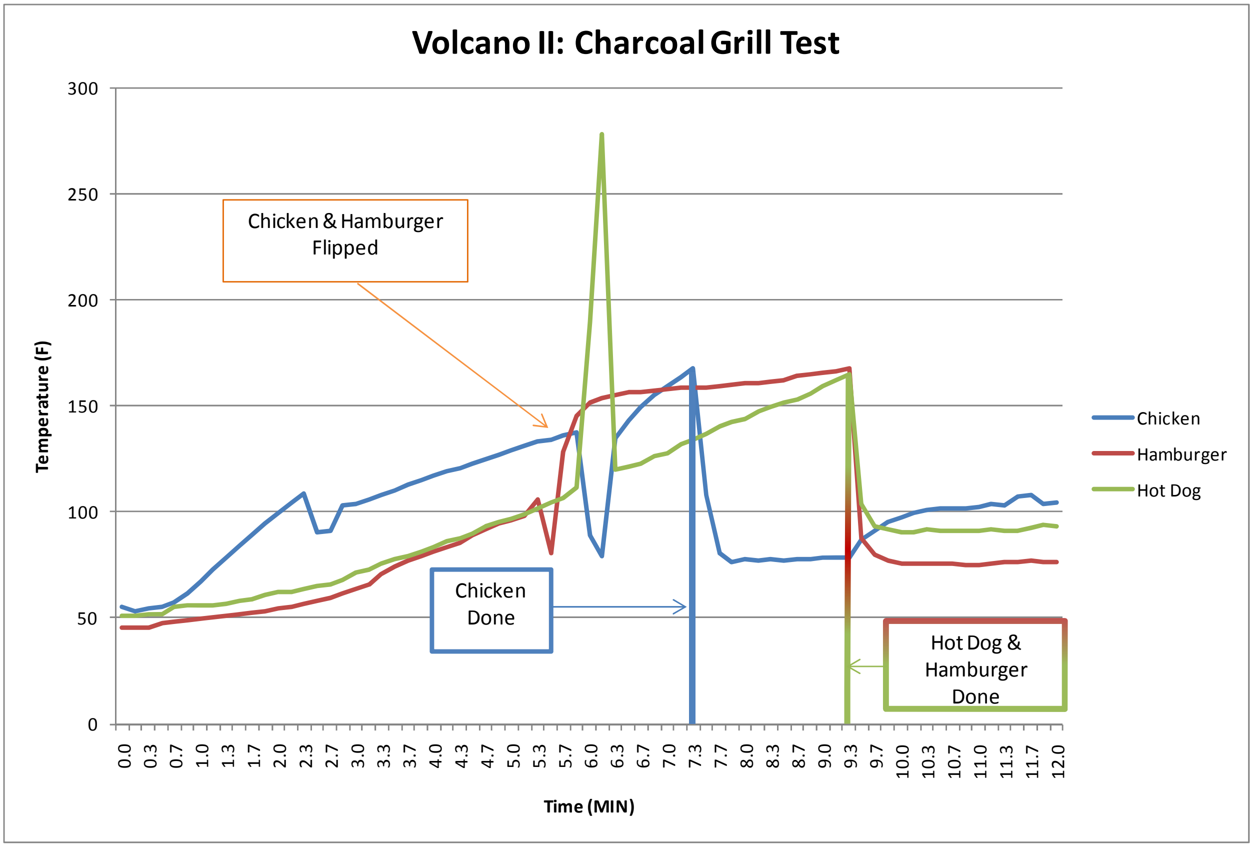


Figure 18. Charcoal Grill Test

Table 5. Charcoal Grill Test Cook Times

Food Item	Cook Time in Minutes
Chicken	**7.2**
Hamburger	**9.2**
Hot Dog	**9.2**

3.2.2 Food Preparation Performance: Grill Test- Wood

During this test the grill was lit in an outdoor environment with wood. After the 5 minute initial warm up, 1 burger, 1 steak, and 1 hot dog were placed on the grill. Their internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached the recommended levels represented in Table 3.

As it can be seen in Figure 18 below, the chicken was finished cooking in approximately 8 minutes, while the hot dog took 4.3 minutes and hamburger took approximately 6.5 minutes to cook. The chicken and hamburger were also flipped at approximately 6 minutes, causing a flare-up which inadvertently caused the hamburger to drastically increase in temperature in a short period of time. These results are also summarized in Table 6.

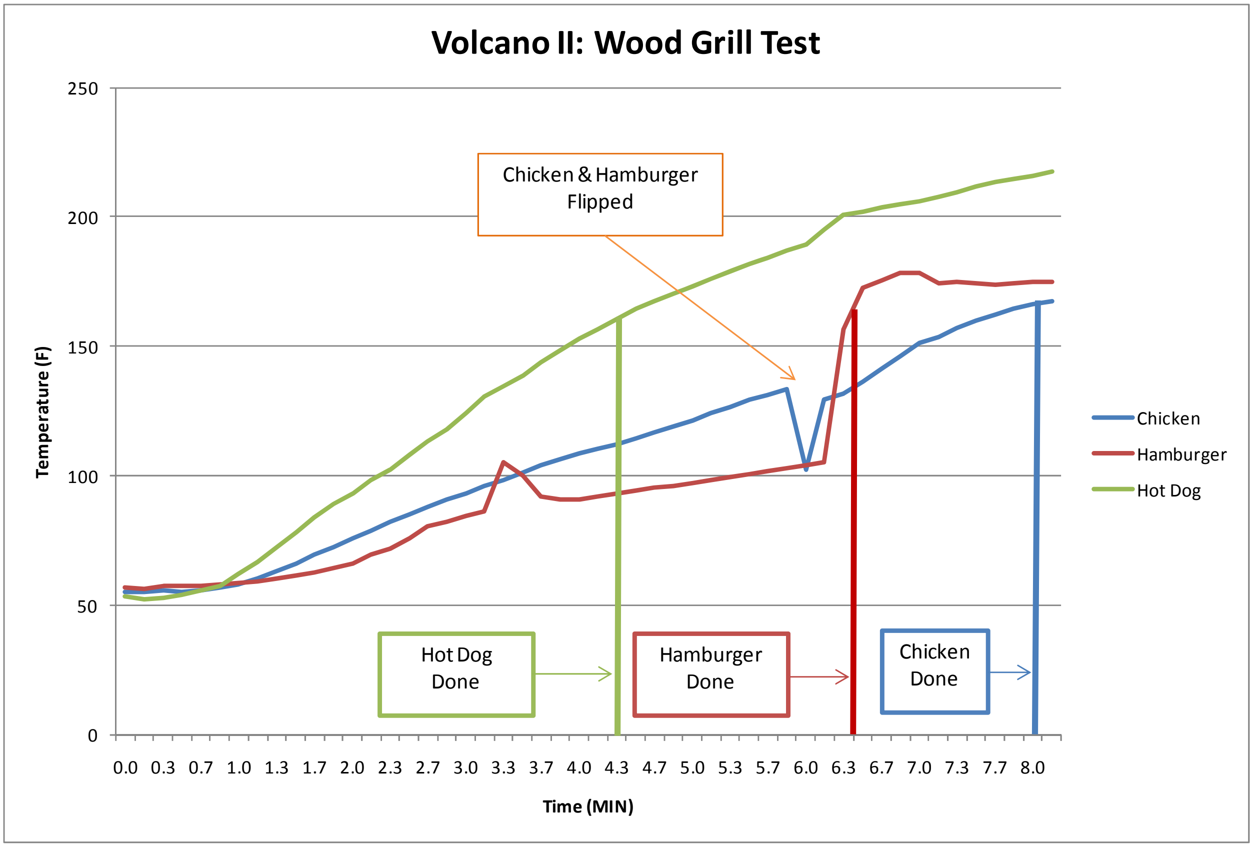


Figure 19. Wood Grill Test

Table 6. Wood Test Grill Times

Food Item	Cook Time in Minutes
Chicken	**8**
Hamburger	**6.5**
Hot Dog	**4.3**

3.2.3 Food Preparation Performance: Grill Test-Propane

The propane grill test was conducted as part of the Throughput test since the same food items were cooked for the throughput test as the grill test.

Referencing the data collected from the Throughput test in section 3.5; hamburgers had an average cook time of 5 minutes when fresh and 16 minutes when frozen, chicken had an average cook time of 11.5 minutes, and hot dogs had an average cook time of 4 minutes. This data is summarized in Table 7 below.

Table 7. Propane Grill Test-Food Items' Average Cook Times

Average Cook Time	Minutes
Burgers Fresh	**5**
Burgers Frozen	**16**

Average Cook Time	Minutes
Chicken	11.5
Hot Dog	4

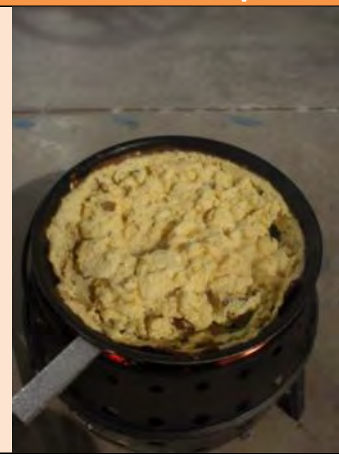
3.3 Food Preparation Performance: Pan Fry Test

Table 8 below outlines the results from the three shallow pan fry tests where propane, charcoal, and wood was used to bring 32oz of egg beaters' egg mix to an edible consistency.

The results showed that the egg mix's cook time was not dependent on fuel source. This was most likely due to the way in which the egg mix was cooked. Allowing the pan to recess in the stove during the cooking process most likely increased the heat transfer performance of the stove as well as trapped more heat underneath the cooking surface. These factors most likely allowed the pan and egg mix to reach a steady state temperature in a similar amount of time, resulting in no difference in cook time.

Table 8. Shallow Pan Fry Test Results

Fuel Source	Cook Time (MIN)	Test Setup
Propane	5	
Charcoal	5	

Fuel Source	Cook Time (MIN)	Test Setup
Wood	5	

3.4 Food Preparation Performance: Oven Test

3.4.1 Food Preparation Performance: Bake Test-Propane

During this test the grill was lit in an outdoor environment with propane. After the 5 minute initial warm up, 4 potatoes were placed onto the Volcano II's top grate. The baking lid was then placed over the stove and the potatoes' internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached 195°F.

As it can be seen in Figure 20 below, all four potatoes finished cooking in approximately 26 minutes, however, due to the various sizes of the potatoes tested, the average cook time was approximately 24.625 minutes.

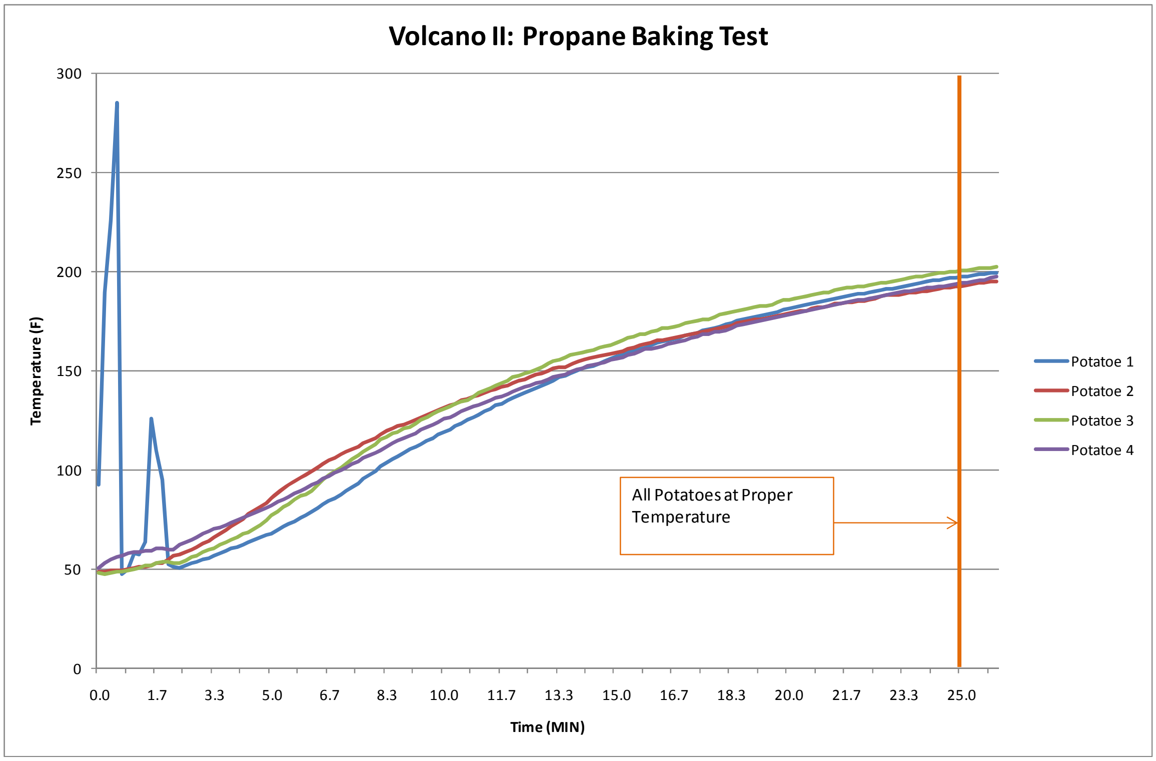


Figure 20. Propane Baking Test Results

3.4.2 Food Preparation Performance: Bake Test-Charcoal

During this test the grill was lit in an outdoor environment with propane. After the 5 minute initial warm up, 4 potatoes were placed onto the Volcano II's top grate. The baking lid was then placed over the stove and the potatoes' internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached 195°F.

As it can be seen in Figure 21 below, all four potatoes finished cooking in approximately 26 minutes, however, due to the various sizes of the potatoes tested, the average cook time was approximately 24.35 minutes.

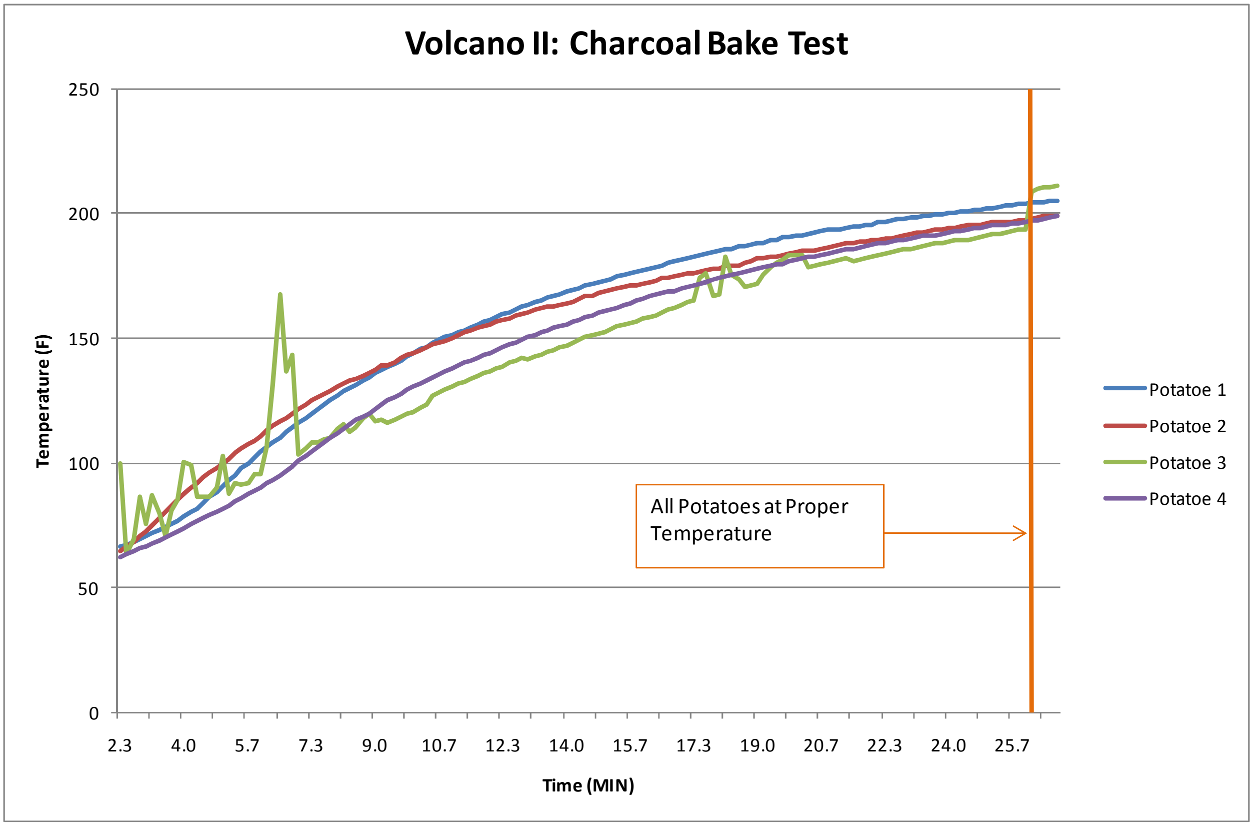


Figure 21. Charcoal Baking Test Results

3.4.3 Food Preparation Performance: Bake Test-Wood

During this test the grill was lit in an outdoor environment with propane. After the 15 minute initial warm up, 4 potatoes were placed onto the Volcano II's top grate. The baking lid was then placed over the stove and the potatoes' internal temperatures were monitored using a Graphtec GL200A data logging system until their internal temperature reached 195°F.

As it can be seen in Figure 22 below, all four potatoes finished cooking in approximately 29.3 minutes, however, due to the various sizes of the potatoes tested, the average cook time was approximately 25.475 minutes. The increased total bake time and average bake time in this case is mostly due to the uneven heat distribution consistent with a wood fire. Large chunks of wood burn for longer and hotter than smaller chunks, affecting the heat distribution to the potatoes. Therefore, any individual potato's cook time is primarily dependent on its position on the grate, hence the 9 minute difference between the first and last potato cooked.

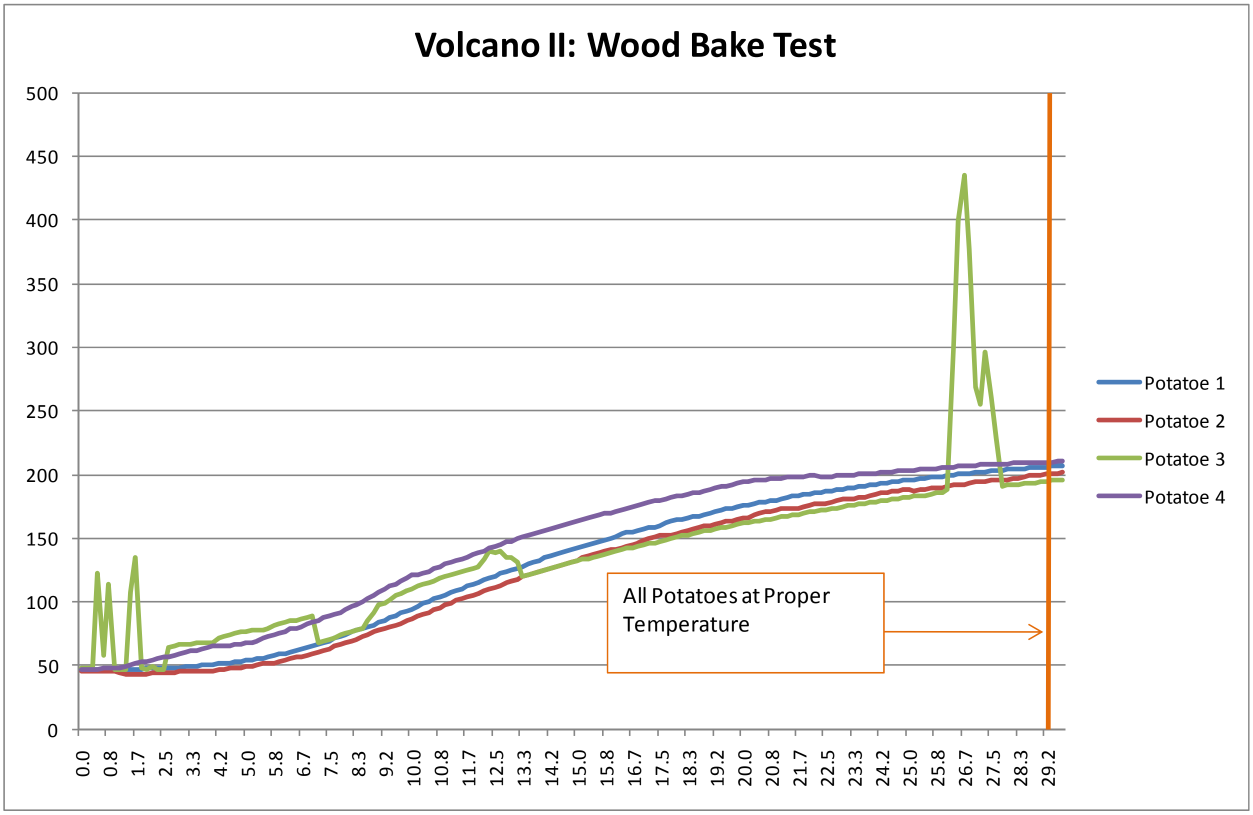


Figure 22. Wood Baking Test Results

3.5 Food Preparation Performance: Throughput Test

During this test, the Volcano II top grate was put onto the stove and the stove was lit in an outdoor environment with propane. The grill was then allowed to pre-heat for approximately 5 minutes. After the initial warm up, like food items (i.e., chili, chicken, hamburgers, hot dogs) were loaded onto the grill in separate loads until the grill's cooking space was completely utilized. The chili was cooked in an 11 qt NSF stock pot with a lid. The Volcano II's baking lid was also used when cooking the chili in order to decrease the chili's cook time by retaining more heat. A summary of each food items, the total weight per load, and a picture of each setup can be seen below in Table 9.

Table 9. Throughput Test Food Items

Food Item	Total Weight Per Load	Test Setup
Chili	150 oz	
Chicken	748 g (Average)	
Hot Dogs	912 g	

Food Item	Total Weight Per Load	Test Setup
Hamburgers	755 g	

A summary of the data collected during the throughput test can also be seen below in Table 10. Concerning the data below, it should be noted that the first load of hamburgers' cook time was drastically less since they were not frozen (5 minutes as opposed to an average of 16 minutes when frozen). The recovery time of the stove, defined as the time necessary for the cooking surface to reach operational temperature once a load is removed, was also instantaneous as the propane flames impinge directly on the grated cooking surface, unlike a standard griddle which must transfer heat through a thick griddle top.

Table 10. Throughput Test Cook Time Data

Volcano II: Throughput Test				
Food Item	**QTY**	**Time ON**	**Time OFF**	**Comments**
Chili	10 Cans	10:30	10:50	Total = 150 oz
Hamurgers	5	11:00	11:05	Fresh
Chicken	5	11:12	11:22	Fresh
Hot Dogs	16	11:25	11:29	Fresh
Hamburgers	5	11:35	11:48	Frozen
Hamburgers	5	12:00	12:20	Frozen
Chicken	6	12:25	12:38	Fresh
Hamburgers	5	12:40	12:55	Frozen
Total Time	**2:25 (Hours)**	**Calories (EA)**		**Total Calories**
Total Burgers Cooked	**20**	**420**		**8400**
Total Chicken Cooked	**11**	**140**		**1540**
Total Hot Dogs Cooked	**16**	**190**		**3040**
Total Chili Cooked	**18.75 Cups**	**236 Per Cup**		**4425**

Reviewing the data in Table 10, it can be determined that the Volcano II is capable of cooking enough food for at least 11 people (squad size) in a reasonable amount of time (2.25 hours) when compared to other field feeding platforms which usually require 2 hours to feed and 1 hour to clean up between meals.

If 11 people were to be fed, each would receive more than one of the above food items, more than likely resulting in a filling meal consisting of an average of 1582 calories. Concerning the above data, it wouldn't be unreasonable to feed 22 people (2 squads), in which case, each person would receive a combination of 2 to 3 food items, most likely resulting in a satisfactory meal consisting of an average of 791 calories. It should also be noted that the above meal calculations do not include any dry food goods or liquids which do not require heating, therefore, if military rations were to be prepared, the dry goods and sport drinks would increase the calorie content by as much as 40%.

3.6 Durability Performance: Drop Test

During this test the Volcano II stove was dropped from a height of 4 ft onto a concrete surface a total of 10 times. During the drop tests the stove was in its collapsed configuration. A picture showing the test procedure setup can be seen below in Figure 23.

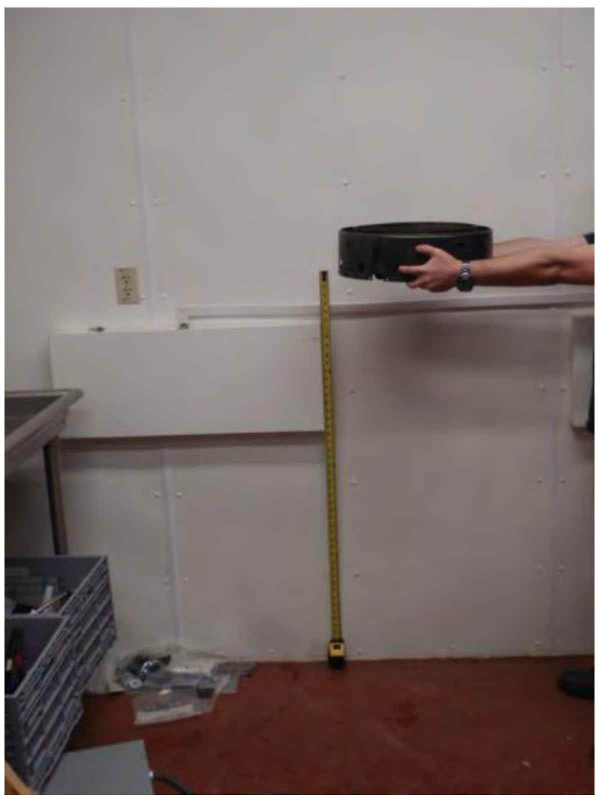


Figure 23. Drop Test Procedure Setup

After the Volcano II stove was dropped 10 consecutive times, the unit was inspected for any damage or loss of functionality.

After close inspection the unit had no visible dents or deformation. The unit also retained full functionality, transitioning from a collapsed configuration to a deployed configuration without incident. The air adjustment mechanism also displayed no signs of damage or loss of functionality.

3.7 Durability Performance: Crush Test

During this test, a 250 Lb force was applied to the Volcano II stove in its collapsed and operational configuration for approximately 1 minute each. This force was applied by placing a piece of sheet metal on top of the stove and placing approximately 5 military issue water cans full of water on the sheet metal with a total combined weight of 250 lbs.

Pictures showing the crush test procedure setup can be viewed in Table 11 below.

Table 11. Crush Test Procedure Setup

Test Configuration	Total Weight Per Load	Test Setup
Collapsed	250 Lbs	
Operational	250 Lbs	

After the Volcano II stove underwent the crush test, the unit was inspected for any damage or loss of functionality.

After close inspection, the unit had no visible dents or deformation caused by the applied force. The unit also retained full functionality, transitioning from a collapsed configuration to a deployed configuration without incident after both tests. The air adjustment mechanism also displayed no signs of damage or loss of functionality.

3.8 Operational Performance: Wind Test

3.8.1 Operational Performance: Wind Test-Propane

During this test the stove was subjected to 1200 CFM of a moving air current for 10 minutes while operating with propane. Figure 24 below shows the Volcano II stove operating with propane under the wind test conditions. As it can be seen in the picture, a fully functional flame is visible, in fact, the flame appeared to burn hotter and larger due to the increased oxygen infused by the blower.

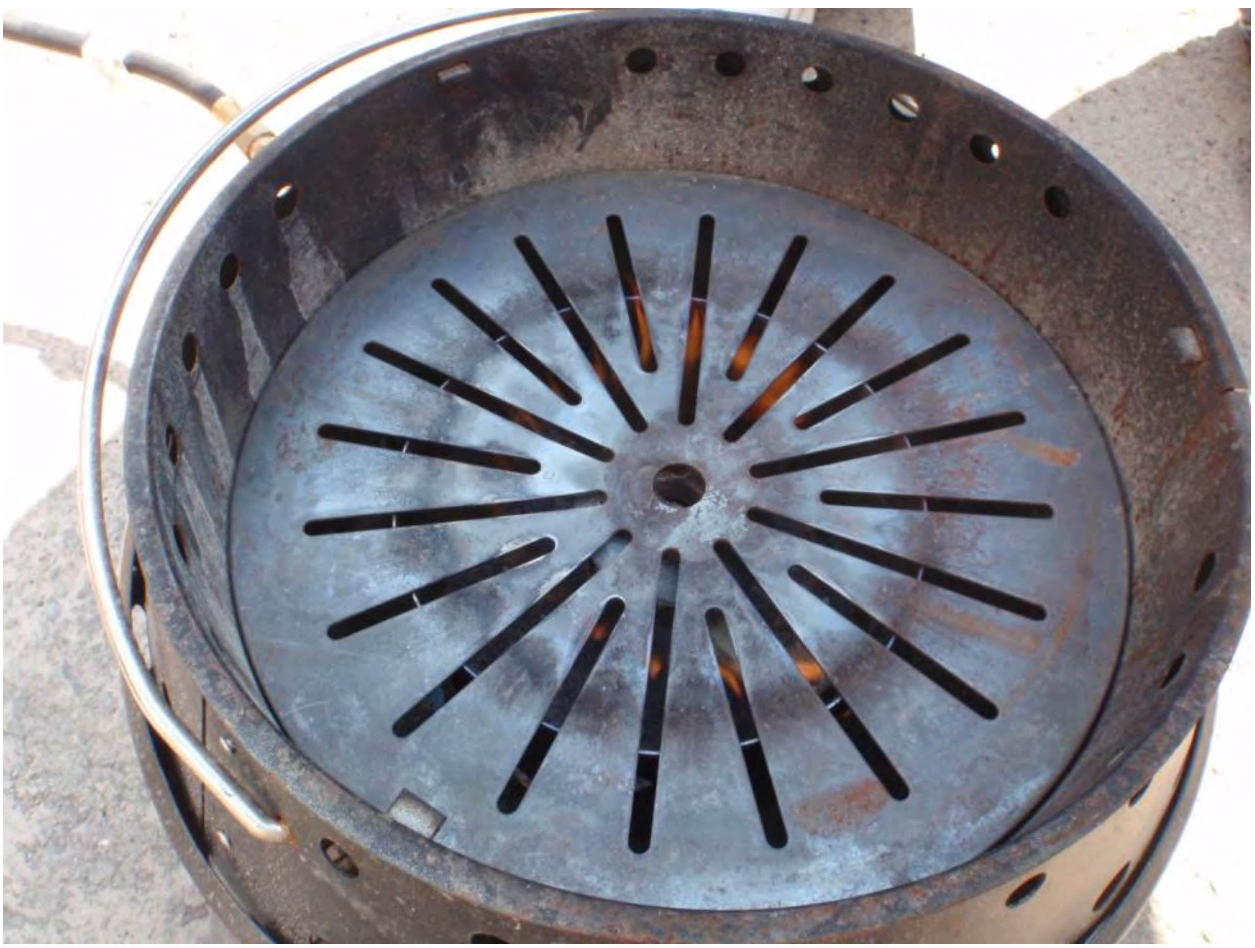


Figure 24. Volcano II Stove Operating With Propane under Wind Test Conditions

A thermal image of the Volcano II stove operating with propane under the wind test conditions can also be viewed below in Figure 25. This thermal image depicts the heat transfer profile generated by the Volcano II stove while operating with propane under the wind test conditions. As it can be seen in the picture below, the flame generated by the propane still creates more than enough heat for practical cooking operations.

Figure 25. Thermal Image of Volcano II Stove Operating With Propane under Wind Test Conditions

3.8.2 Operational Performance: Wind Test-Charcoal

During this test the stove was subjected to 1200 CFM of a moving air current for 10 minutes while operating with charcoal. Figure 26 below shows the Volcano II stove operating with charcoal under the wind test conditions. As it can be seen in the picture, red hot coals are visible, in fact, much like the propane wind test, the charcoal appeared to burn hotter due to the increased oxygen infused by the blower.

Figure 26. Volcano II Stove Operating With Charcoal under Wind Test Conditions

3.8.3 Operational Performance: Wind Test-Charcoal

During this test the stove was subjected to 1200 CFM of a moving air current for 10 minutes while operating with wood. Figure 27 below shows the Volcano II stove operating with charcoal under the wind test conditions. As it can be seen in the picture, charred wood with flames are visible, in fact, much like the propane and charcoal wind test, the wood appeared to burn hotter due to the increased oxygen infused by the blower.

Figure 27. Volcano II Stove Operating with Wood under Wind Test Conditions

3.9 Operational Performance: Water Resistance Test

3.9.1 Operational Performance: Water Resistance Test-Propane

During this test, water at a flow rate of 0.5 gallons per minute was showered over the stove while operating with propane for approximately 5 minutes from a height of approximately 6 ft by using a standard shower nozzle attached to a standard garden hose which was set on the "mist" setting. This test was conducted with the Volcano II baking lid over the stove in order to determine the lid's ability to increase the stove's performance under heavy rain conditions.

During the water resistance test, it was noted that the baking lid produced a somewhat significant amount of steam due to the cold water contacting the hot baking lid, but otherwise no loss in functionality occurred.

The baking lid steaming during the water resistance test as well as the quality of the flame after the water test's conclusion can be seen in Figure 28 and Figure 29 respectively.

Figure 28. Baking Lid Operating During Propane Water Resistance Test

Figure 29. Propane Flame Quality After Water Resistance Test

3.9.2 Operational Performance: Water Resistance Test-Charcoal

During this test, water at a flow rate of 0.5 gallons per minute was showered over the stove while operating with charcoal for approximately 5 minutes from a height of approximately 6 ft by using a standard shower nozzle attached to a standard garden hose which was set on the "mist" setting. This

test was conducted with the Volcano II baking lid over the stove in order to determine the lid's ability to increase the stove's performance under heavy rain conditions.

During the water resistance test, it was noted that the baking lid produced less steam during operation as compared when operating with propane. No loss in functionality was recorded and the quality of the charcoal heat after the water resistance test appeared normal with a hot cherry red center.

The quality of the charcoal after the water test's conclusion can be seen in Figure 30 below.

Figure 30. Charcoal Quality after Water Resistance Test

3.9.3 Operational Performance: Water Resistance Test-Wood

During this test, water at a flow rate of 0.5 gallons per minute was showered over the stove while operating with wood for approximately 5 minutes from a height of approximately 6 ft by using a standard shower nozzle attached to a standard garden hose which was set on the "mist" setting. This test was conducted with the Volcano II baking lid over the stove in order to determine the lid's ability to increase the stove's performance under heavy rain conditions.

During the water resistance test, it was noted that the baking lid produced similar amounts of steam during operation as compared when operating with propane. After testing it was apparent that the flame was snuffed out due to minimal amounts of water intrusion or lack of oxygen (Figure 31),

however, the wood appeared dry and hot. A thermal image of the wood was taken to verify the wood was still smoldering. As it can be seen below in Figure 32, while no flame is apparent, the wood was still extremely hot with pieces of wood essentially still ignited at temperatures exceeding 1000°F. This smoldering wood was easily re-ignited within a few minutes, returning the stove back to full functionality as can be seen in Figure 33 below.

Figure 31. Wood Water Resistance Test Results-No Flame Apparent

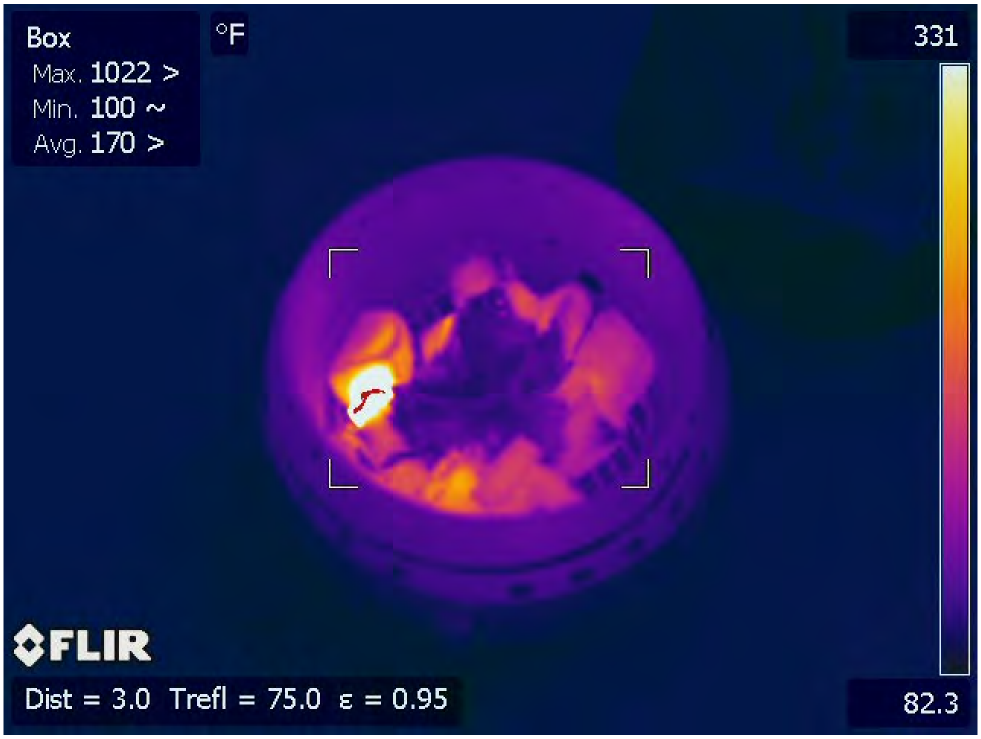


Figure 32. Wood Water Resistance Test- Thermal Image-No Flame Apparent

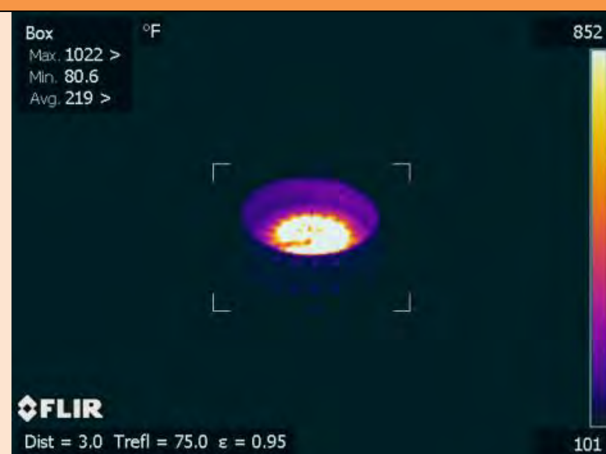
Figure 33. Wood Water Resistance Test-Wood Re-Ignited

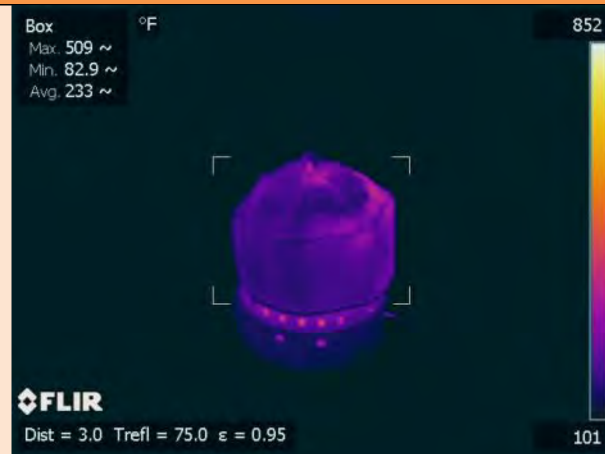
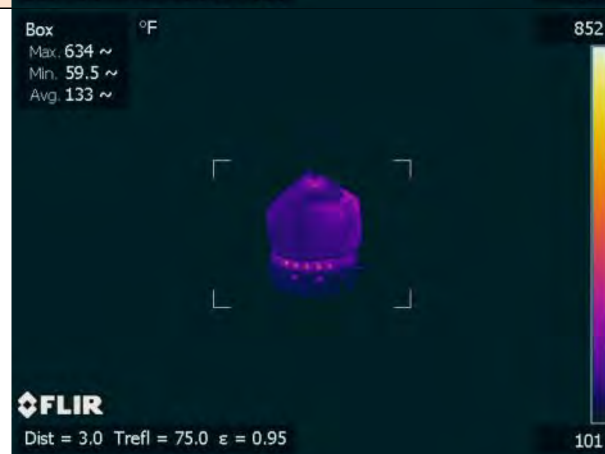
3.10 Operational Performance: Heat Signature Test

During this test, the stove was lit in an outdoor environment with propane, charcoal, and wood. The stove was then left to run for approximately 10 minutes. After 10 minutes of run time, a thermal image of the stove was taken at approximately a 10 ft distance and then a 5 ft distance. The stove was then covered with the Volcano II baking lid and left to run for an additional 10 minutes. After the additional 10 minutes of covered run time, a thermal image was taken of the covered stove at a distance of approximately 10 ft and 5 ft. Table 12 below summarizes the results from the heat signature test.

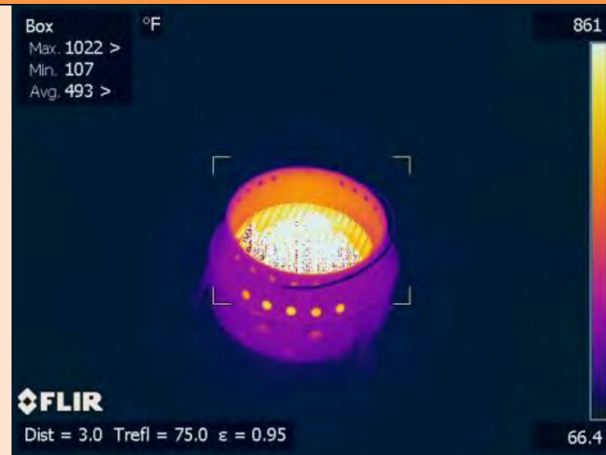
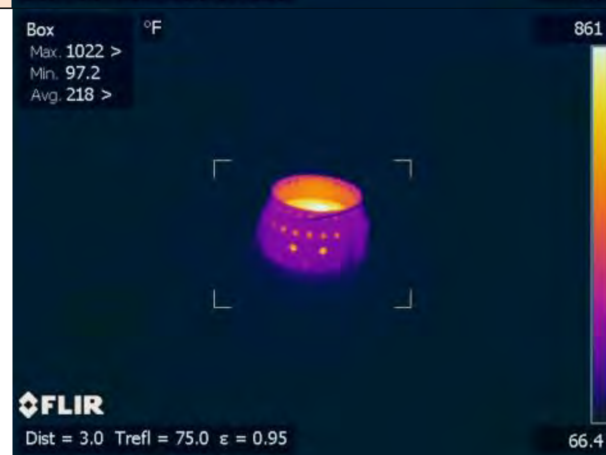
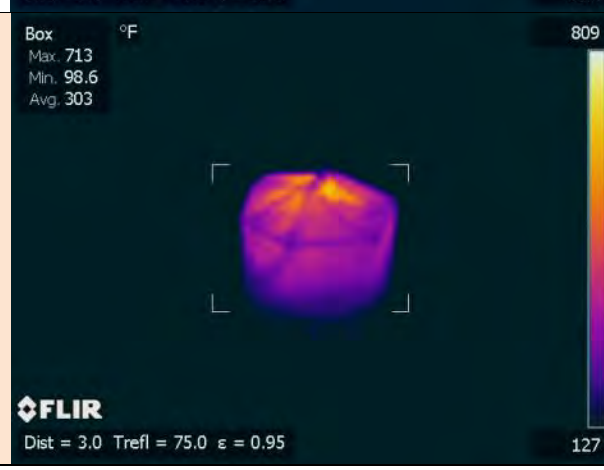
As it can be seen in the table below, utilizing the Volcano II's baking lid during cooking applications reduces the intensity of the appliance's heat signature. This can be seen in the fact that when the stove is uncovered, its max visible infrared temperature is on average 343.6°F hotter at a 5 ft distance and an average 270°F hotter at a 10 ft distance. This means that when utilizing the Volcano II's baking lid during operation, the stove as a whole emits less intense infrared radiation, resulting in a less noticeable, and therefore less detectable thermal profile. This is especially prevalent when viewing the stove from above, where when used without the baking lid, the most intense infrared radiation is not blocked from view from the sides of the stove.

Table 12. Heat Signature Test Results

Fuel Used	Configuration	Distance (ft)	Max Temp	Average Temp	Thermal Profile
Propane	Uncovered	5	1022	219	
Propane	Uncovered	10	973	98.8	

Fuel Used	Configuration	Distance (ft)	Max Temp	Average Temp	Thermal Profile
Propane	Covered	5	509	233	
Propane	Covered	10	634	133	
Charcoal	Uncovered	5	1022	430	

Fuel Used	Configuration	Distance (ft)	Max Temp	Average Temp	Thermal Profile
Charcoal	Uncovered	10	840	120	
Charcoal	Covered	5	813	255	
Charcoal	Covered	10	745	160	

Fuel Used	Configuration	Distance (ft)	Max Temp	Average Temp	Thermal Profile
Wood	Uncovered	5	1022	493	
Wood	Uncovered	10	1022	218	
Wood	Covered	5	713	303	

Fuel Used	Configuration	Distance (ft)	Max Temp	Average Temp	Thermal Profile
Wood	Covered	10	646	139	

4. Conclusions and Recommendations

After analysis of the food preparation and operational performance tests conduction on the Volcano II Collapsible stove, a few conclusions can be made concerning its field feeding capability, operational performance and durability.

4.1 Conclusions and Recommendations: Field Feeding Capability

Reviewing the results from the food preparation tests performed in sections 2.1-2.5, it can be concluded that the Volcano II can effectively boil, bake, pan-fry and grill, giving the stove an advantage over currently fielded squad stoves which can't bake or effectively pan-fry/grill. It can also be concluded that utilizing the Volcano II's baking lid during operation can improve food preparation performance. It can also be concluded that the Volcano II is capable of feeding at the squad sized level (8-11 men) if not multiple squads (16-22 men).

4.2 Conclusions and Recommendations: Operational Performance

Reviewing the results from the operational performance tests performed in sections 2.8-2.10, it can be concluded that the Volcano II can effectively operate in austere conditions where heavy wind and rain is present. It can also be concluded that utilizing the Volcano II's baking lid during operation can reduce the stove's overall heat signature, especially from above. It can also be concluded from its overall design that the stove's ability to collapse aides in its ability to be easily transported and stored.

4.3 Conclusions and Recommendations: Durability

Reviewing the results from the durability tests performed in section 0 and 2.7, it can be concluded that the Volcano II is capable of enduring rough handling and storage without damage or loss of functionality.

APPENDIX I: RELIABILITY & MAINTAINABILITY FIGURES DERIVATIONS

NAVAL POSTGRADUATE SCHOOL

SE311-101O CAPSTONE PROJECT

15 August 2011

Reliability and Maintenance Derivations

FOR THE

HUMANITARIAN ASSISTANCE SHELTER SYSTEM

SUBMITTED BY: ______________________________ DATE: ___________________

Cohort 311-101O

Naval Postgraduate School

CONCURRENCE: ______________________________ DATE: ___________________

Brigitte Kwinn

Technical Advisor

Naval Postgraduate School

APPROVAL: ______________________________ DATE: ___________________

Dr. David H. Olwell

Capstone Project Director

Naval Postgraduate School

CAPSTONE PROJECT SE311-101O

NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

Record of Changes:

Date	Revision	Reason for Change	Entered by:
15 AUG 11	1	Initial Submission	B. Williams

Table of Contents

List of Tables

1.0 Reliability and Maintenance Derivations for the Humanitarian Assistance Shelter System (HASS)

1.1 Approach

In order to determine reliability and maintenance requirements for the HASS system specification, a reliability and maintenance analysis was performed. This analysis was performed by making assumptions to specific values required to perform the analysis. These assumptions were made due to the fact that reliability and maintenance testing could not be performed on the HASS in the time allotted for this project. These assumptions were based off estimates determined by the project team's research, the HASS CONOPS, and the conceptual design of the HASS itself. A complete table of the values assumed during the analysis can be seen below in Table 1.

Table 1 Reliability and Maintenance Assumptions

Known Values (Assumptions)		
Name	**Value**	**Units**
Life Cycle	21914	Hrs
Mean Corrective Maintenance Time ($\bar{M}ct$)	1	Hrs
Mean Preventive Maintenance Time ($\bar{M}pt$)	0.5	Hrs
Mean Interval Between Preventive Maintenance ($MTBM_s$)	720	Hrs
Mean Interval Between Corrective Maintenance ($MTBM_u$)	4320	Hrs

1.2 Calculations

Using the values assumed in Table 1 above, the reliability and maintenance values required for the HASS system specification were calculated. These values and the corresponding equations from which they were derived can be viewed in Table 2 and Table 3 respectively.

Table 2 Calculated Reliability & Maintenance Values

Calculated Values	Symbol	Value	Units
Mean Active Maintenance Time	$\bar{M}$	35	Average time to perform any maintenance task (Minutes)
(Frequency of Corrective Maintenance)	λ	0.00023	Actions per Operating Hour
(Frequency of Preventive Maintenance)	fpt	0.00139	Actions per Operating Hour
Mean Interval of Corrective Maintenance	MTBMu	4320	Hrs
Mean Interval of Preventive Maintenance	MTBMs	720	Hrs
Mean Time Between All Maintenance Actions	MTBM	617	Hrs
Achieved Availability	Aa	95	%

Table 3 Equation Citations[1]

Equations			Citation	
Symbol	Equation	Description	Book	Page #
$\bar{M}$	$\bar{M} = \frac{(\lambda)(\bar{M}ct) + (fpt)(\bar{M}pt)}{\lambda + fpt}$	Mean Active Maintenance Time	B&F	429

1

Benjamin S. Blanchard, W. J. (2006). *Systems Engineering and Analysis, Fourth Edition.* Upper Saddle River, New Jersey 07458: Pearson Prentice Hall, Pearson Education Inc. .

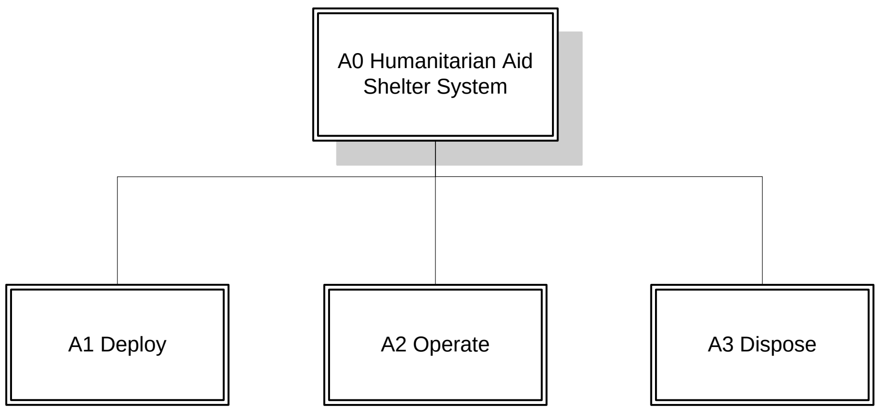
Equations			Citation	
Symbol	**Equation**	**Description**	**Book**	**Page #**
λ	$\frac{1}{MTBM_u}$	Frequency of Corrective Maintenance	B&F	428
fpt	$\frac{1}{MTBM_s}$	Frequency of Preventive Maintenance	B&F	428
MTBMu	Average of intervals between corrective maintenance	Mean Interval of Corrective Maintenance	B&F	433
MTBMs	Average of intervals between preventive maintenance	Mean Interval of Preventive Maintenance	B&F	433
MTBM	$MTBM = \frac{1}{1/MTBM_u + 1/MTBM_s}$	Mean Time Between All Maintenance Actions	B&F	432
A_a	$A_a = \frac{MTBM}{MTBM + \overline{M}}$	Achieved Availability (Reliability)	B&F	436

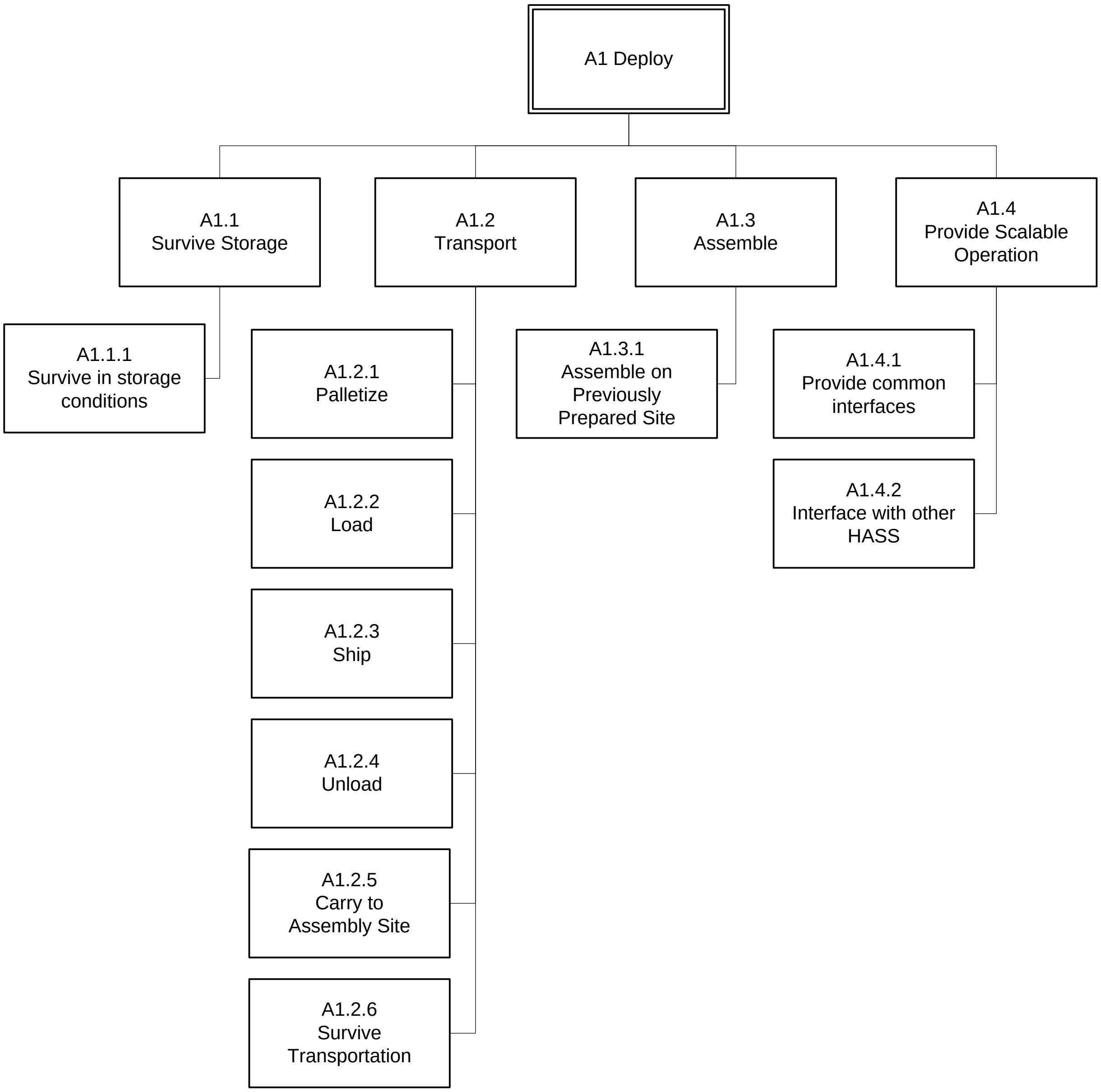
1.3 Utilization

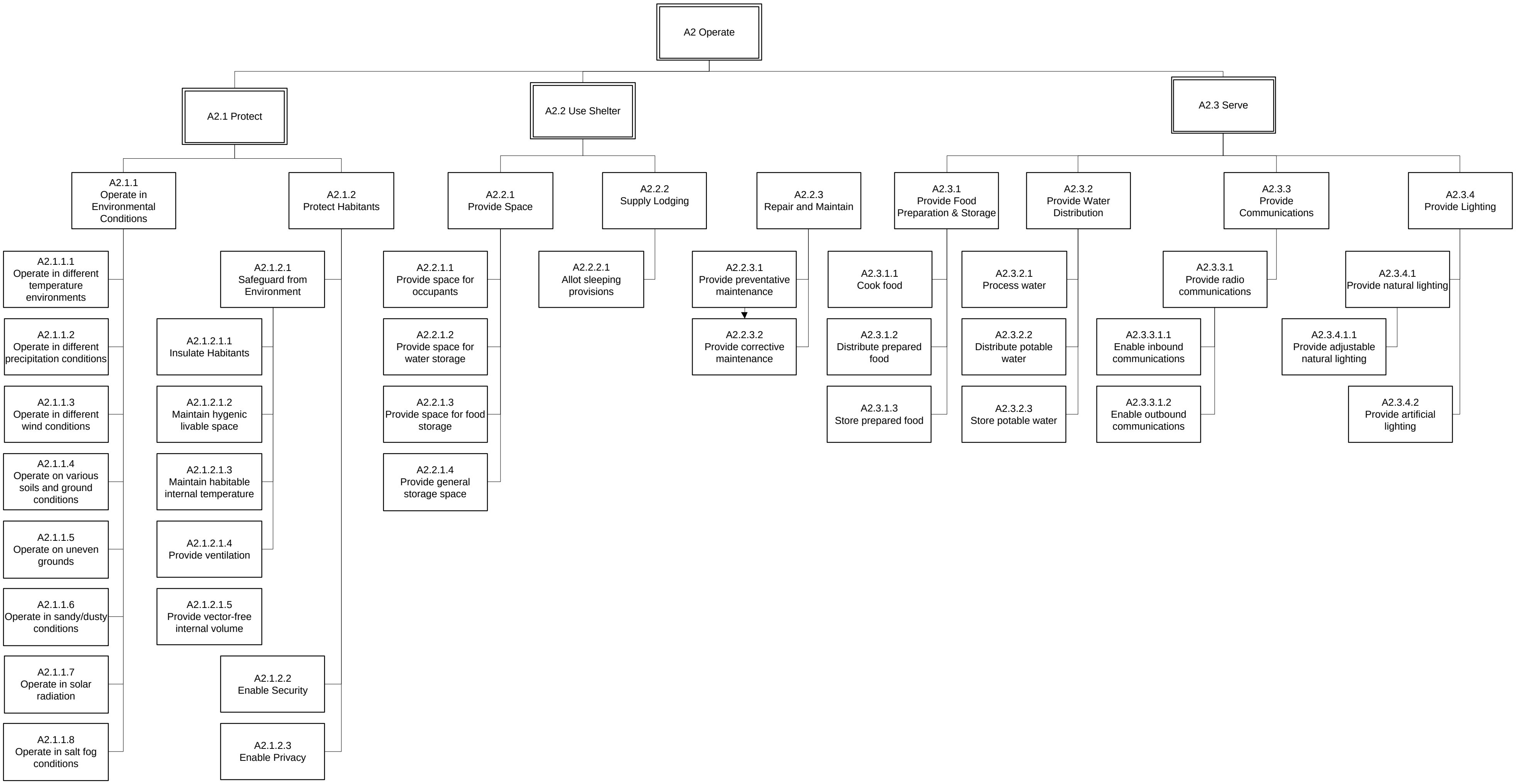
The resulting values from Table 2 for achieved availability (A_a), mean active maintenance time ($\overline{M}$) and mean time between maintenance (MBTM) were integrated into the HASS system specification upon completion of this analysis. These values, combined with non-numeric specific reliability/maintenance requirements, allow the HASS to have a well defined set of requirements which prescribe expected intervals and durations for corrective and preventive maintenance.

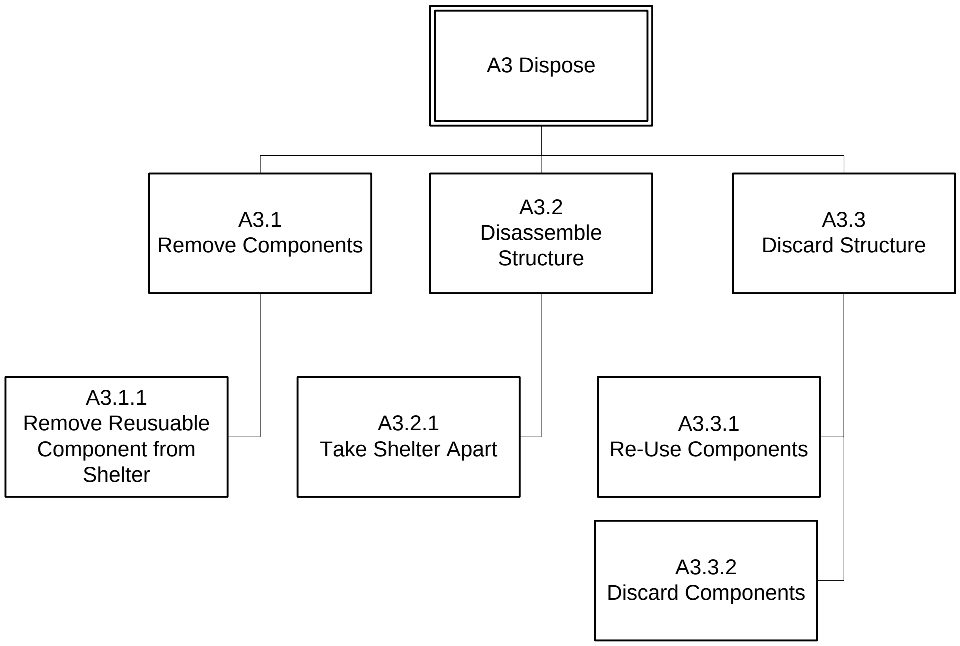
APPENDIX J: SV-4A

HASS Systems Functionality Description (SV-4a)




A1 Deploy
A1.1
Survive Storage
A1.2
Transport
A1.3
Assemble
A1.4
Provide Scalable
Operation
A1.1.1
Survive in storage
conditions
A1.2.1
Palletize
A1.2.2
Load
A1.2.3
Ship
A1.2.4
Unload
A1.2.5
Carry to
Assembly Site
A1.2.6
Survive
Transportation
A1.3.1
Assemble on
Previously
Prepared Site
A1.4.1
Provide common
interfaces
A1.4.2
Interface with other
HASS


A2 Operate
A2.1 Protect
A2.2 Use Shelter
A2.3 Serve
A2.1.1 Operate in Environmental Conditions
A2.1.2 Protect Habitants
A2.2.1 Provide Space
A2.2.2 Supply Lodging
A2.2.3 Repair and Maintain
A2.3.1 Provide Food Preparation & Storage
A2.3.2 Provide Water Distribution
A2.3.3 Provide Communications
A2.3.4 Provide Lighting
A2.1.1.1 Operate in different temperature environments
A2.1.1.2 Operate in different precipitation conditions
A2.1.1.3 Operate in different wind conditions
A2.1.1.4 Operate on various soils and ground conditions
A2.1.1.5 Operate on uneven grounds
A2.1.1.6 Operate in sandy/dusty conditions
A2.1.1.7 Operate in solar radiation
A2.1.1.8 Operate in salt fog conditions
A2.1.2.1 Safeguard from Environment
A2.1.2.1.1 Insulate Habitants
A2.1.2.1.2 Maintain hygenic livable space
A2.1.2.1.3 Maintain habitable internal temperature
A2.1.2.1.4 Provide ventilation
A2.1.2.1.5 Provide vector-free internal volume
A2.1.2.2 Enable Security
A2.1.2.3 Enable Privacy
A2.2.1.1 Provide space for occupants
A2.2.1.2 Provide space for water storage
A2.2.1.3 Provide space for food storage
A2.2.1.4 Provide general storage space
A2.2.2.1 Allot sleeping provisions
A2.2.3.1 Provide preventative maintenance
A2.2.3.2 Provide corrective maintenance
A2.3.1.1 Cook food
A2.3.1.2 Distribute prepared food
A2.3.1.3 Store prepared food
A2.3.2.1 Process water
A2.3.2.2 Distribute potable water
A2.3.2.3 Store potable water
A2.3.3.1 Provide radio communications
A2.3.3.1.1 Enable inbound communications
A2.3.3.1.2 Enable outbound communications
A2.3.4.1 Provide natural lighting
A2.3.4.1.1 Provide adjustable natural lighting
A2.3.4.2 Provide artificial lighting


A3 Dispose
A3.1
Remove Components
A3.2
Disassemble
Structure
A3.3
Discard Structure
A3.1.1
Remove Reusuable
Component from
Shelter
A3.2.1
Take Shelter Apart
A3.3.1
Re-Use Components
A3.3.2
Discard Components

APPENDIX K: REQUIREMENTS & FUNCTIONAL ISSUES CORE EXPORT

Appendix K – CORE-Documented HASS Requirements and Functional Issues

The below table captures issues identified in CORE during the requirements analysis process. Items described required collaboration with team members to resolve. All but two issues are resolved; the remaining open issues require a follow-on stage of development to be addressed by another Capstone Team.

Issue Status	**Issue #**	**Issue Name**	**Issue Description**	**Associated Requirements/ Functions**	**Assumptions**	**Decision**
Closed	Issue. 1	-> MNS - Redundant Shelf Life Requirement	This first statement in the MNS.1.1.2 requirement seems redundant to the cited MNS.1.2.10 requirement. ----Current statement of the MNS.1.1.2 requirement is, "The HASS shall survive a shelf life in accordance with MNS.1.2.10 of this Specification. The HASS system shall survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed. Operational duration is defined as any time outside of shelf time."	Requirement MNS.1.1.2 Operational Lifecycle	Adds no value.	Interpreted and addressed.
Closed	Issue. 2	-> MNS - Use of Phrase "..of Shelters" in Reliability requirement	Not sure what is intended by “of shelters” in the statement of the MNS.1.1.6 Reliability requirement, occuring right after "99% (Objective)". Suggest deletion. ---- Current requirement is stated as, "The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95% (Threshold) and 99% (Objective) of shelters with a lower bound 90% confidence interval. An essential functional failure is a failure of certain major components or systems of the HASS that cannot be repaired by the user. Major	Requirement MNS.1.1.6 Reliability	Impacts clarity of requirement.	Clarification made.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			components are defined as any component in which a failure leads to the shelter being uninhabitable."			
Closed	Issue. 3	-> MNS - Use of Phrase "..or systems" in Essential Functional Failures definition with Reliability Requirement	"..or systems" appears to be extraneous text in the Essential Functional Failures definition associated with the MNS.1.1.6 Reliability Requirement. Suggest deletion. ---- Current requirement is stated as, "The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95% (Threshold) and 99% (Objective) of shelters with a lower bound 90% confidence interval. An essential functional failure is a failure of certain major components or systems of the HASS that cannot be repaired by the user. Major components are defined as any component in which a failure leads to the shelter being uninhabitable."	Requirement MNS.1.1.6 Reliability	Text has no added value.	Clarification made.
Closed	Issue. 4	-> MNS - Version of MIL-STD-1472	The version of MIL-STD-1472 is not stated in the first sentence of MNS.1.2.8 Human Engineering requirement, and, as a result, it is an insufficiently defined constraint. ---- Current requirement is stated as, "The HASS shall be operable and maintainable by the full range of personnel (5th percentile female through 95th percentile male) in accordance with applicable sections of MIL-STD-1472. The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and	Requirement MNS.1.2.8 Human Engineering	Intent is to properly define a system constraint	Analysis performed and system spec cites the latest version from stakeholder input.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			perform all required tasks. The HASS components shall be capable of 2 person lift."			
Closed	Issue. 5	-> MNS - Use of Phrase "work area"	The phrase "work area" seems inappropriate as used in the second sentence of the MNS.1.2.8 Human Engineering requirement. ---- Current requirement is stated as, "The HASS shall be operable and maintainable by the full range of personnel (5th percentile female through 95th percentile male) in accordance with applicable sections of MIL-STD-1472. The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and perform all required tasks. The HASS components shall be capable of 2 person lift.".	Requirement MNS.1.2.8 Human Engineering	Intent is to describe living space.	Tabled.
Closed	Issue. 6	-> MNS - Insufficient NEPA Standard Identification	There is no identification of National Environmental Protection Agency (NEPA) standards in the first sentence of MNS.1.2.9 Materials requirement, and, as a result, it is an insufficiently defined constraint. ---- Current requirement is stated as, "HASS shall not contain any materials hazardous to the occupant's health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial	Requirement MNS.1.2.9 Materials	Intent is to properly define a system constraint	Interpreted as vague user intent.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			practice. All components of the HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F. ".			
Closed	Issue. 7	-> MNS - Insufficient International Standard Identification	There is no identification of National Environmental Protection Agency (NEPA) standards in the first sentence of MNS.1.2.9 Materials requirement, and ,as a result, it is an insufficiently defined constraint. ---- Current requirement is stated as, "HASS shall not contain any materials hazardous to the occupant's health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the HASS shall	Requirement MNS.1.2.9 Materials	Intent is to properly define a system constraint	Interpreted as vague user intent.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F. ".			
Closed	Issue. 8	-> MNS - Insufficient Federal Regulations Identification	There is no identification of Federal regulations in the second sentence of MNS.1.2.9 Materials requirement, and, as a result, it is an insufficiently defined constraint. ----Current requirement is stated as, "HASS shall not contain any materials hazardous to the occupant's health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent	Requirement MNS.1.2.9 Materials	Intent is to properly define a system constraint	Interpreted as vague user intent.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F. ".			
Closed	Issue. 9	-> MNS - COTS vs. recycled, recovered, or environmentally preferable materials	There appears to be a conflict between the fourth sentence of the MNS.1.2.9 Materials requirement and the MNS.1.3.5 Shelter Components requirement. It is not clear how recycled, recovered, or environmentally preferable materials shall be used with all HASS components and still expect the components to all be COTS. ----Current MNS.1.2.9 Materials requirement is stated as, "HASS shall not contain any materials hazardous to the occupant's health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the	Requirement MNS.1.2.9 Materials Requirement MNS.1.3.5 Shelter Components	All requirements are achievable concurrently to provide the required capability.	Clarification made is system specification to address HASS modification.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
			HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F. ". ----Current MNS.1.3.5 Shelter Components requirement is stated as, "The HASS shall maximize use of COTS components."			
Closed	Issue. 10	-> MNS - Insufficient Clarity in Color Requirement	The second sentence of the MNS.1.3.4 Color Requirement needs clarification, as it appears meaningless as-is. ----Current statement of the requirement is, "Military or camouflage colors shall not be used. Cultural and political sensitivities shall be taken into account, for example in the use of colors used in national or factional flags in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft".	Requirement MNS.1.3.4 Color	Intent is to provide a clear set of requirements.	Interpreted as vague user intent.
Closed	Issue. 11	-> MNS - Inappropriate Use of an Example in a	It is inappropriate to use an example in a requirement statement. The second sentence in the MNS.1.3.4 Color requirement does so. ----Current statement of the requirement is,	Requirement MNS.1.3.4 Color	Intent is to specify verifiable requirements	Interpreted as vague user intent.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
		Requirement	"Military or camouflage colors shall not be used. Cultural and political sensitivities shall be taken into account, for example in the use of colors used in national or factional flags in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft".		that do not rely on examples to support their specification.	
Closed	Issue. 12	-> MNS Salt Spray trace to SYS Salt Fog	MNS defines a mission need for operation without degradation in a 'salt spray' environment. System Specification defines a requirements for operation without degradation in a 'salt fog' environment	Requirement MNS.1.1.1.1.C Salt Spray Extreme Operations Requirement MNS.1.1.1.2.C Degradation in Salt Spray Extremes Requirement SYS.1.3.2.12 Salt Fog	Salt spray exposure is equivalent to Salt Fog exposure	Trace established using as is requirements.
Closed	Issue. 13	-> SYS - Missing HASS Fog Environmental Requirement in System Specification	System Specification is missing a HASS Environmental Requirement for operation without degradation in a Fog Environment.	Requirement MNS.1.1.1.2.D Degradation in Fog Extremes	Traceability with MNS is desired.	Trace made to Salt fog in the System Spec from Salt Spray and Fog in the MNS
Closed	Issue. 14	-> SYS - Orphan Vibration requirements in system spec	System Specification Vibration Requirements do not appear to have parentage in MNS.	Requirement SYS.1.3.3.5 Operation After Vibration Exposure Requirement SYS.1.3.4.5.C.1 HASS Transport	Intent is for HASS to survive during and after vibration events during	Operation "During" event removed from operation requirements.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
				Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation	transportation and operation.	
Closed	Issue. 15	-> SYS - Orphan High Altitude Operation Rqmt in System Spec	High Altitude Operation requirement has no parentage in MNS.	Requirement SYS.1.3.3.6.2 High Altitude Operation	Intent is not to expand requirements beyond those identified in the MNS	Derivation of requirement considered acceptable, given appropriate consideration of breadth of the disaster threat.
Closed	Issue. 16	-> SYS - Missing Requirements for Skills/ Training for HASS Operation, i.e., High Altitude documentation	High Altitude documentation requirement states documentation shall be provided if different than that required for operation at sea level. This points out the need for requirements for Skills/Training for HASS Operation -->Related to Issue.17	Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures	Requirements needed.	Requirement s developed.
Closed	Issue. 17	-> SYS - Missing Requirements in System Spec for	The system specification contains no requirements for Assembly. As a result we can not establish a relationship with Function 1.3 Assemble <the HASS>. -->Related to Issue.16	Requirement SYS.1.3.3 Performance Requirements	Intent is to capture a complete set of requirements	Requirement s created.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
		Assembly			for the HASS with no gaps in functionality.	
Closed	Issue. 18	-> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements. Different standards are used.	Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement SYS.1.3.4.2.A.1 HASS Class A Health Hazardous Materials Requirement SYS.1.3.4.2.A.2	Traceability should exist	Traceability established with SME advice.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
				HASS Class C Health Hazardous Materials Requirement SYS.1.3.4.2.A.3 HASS Class D Health Hazardous Materials Requirement SYS.1.3.4.2.A.4 HASS Class E Health Hazardous Materials Requirement SYS.1.3.4.2.A.5 HASS Class F Health Hazardous Materials		
Closed	Issue. 19	-> SYS - HASS Modification with Locally Available Materials - Redundant and Does not Trace from MNS	SYS.1.3.4.2.1.C, HASS Modification with Locally Available Materials, is a Redundant phrase that Does not Trace from MNS and spawns another requirement.	Requirement SYS.1.3.4.2.1.C HASS Modification with Locally Available Materials		Requirement added. Derived.
Closed	Issue. 20	-> Sys Spec requirement on Use of Flammable Liquids does not trace from	Sys Spec requirements SYS.1.3.4.2.3.A.1, SYS.1.3.4.2.3.A.2 and SYS.1.3.4.2.3.A.3 on Use of Flammable Liquids do not trace from MNS.	Requirement SYS.1.3.4.2.3.A.1 Flammable Liquids Use per OSHA 1926.152 Class 1A Requirement	Oversight	Option B. Trace made from MNS as is.

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
		MNS		SYS.1.3.4.2.3.A.2 Flammable Liquids Use per OSHA 1926.152 Class 1B Requirement SYS.1.3.4.2.3.A.3 Flammable Liquids Use per OSHA 1926.152 Class 1C		
Closed	Issue. 21	-> SYS - Insufficient Requirement - Toxicity of Materials causing Injuries	Shredding of System Spec Requirement on Toxicity of Materials reveals an insufficiently formed requirement regarding causing injuries (SYS.1.3.4.2.4.B).	Requirement SYS.1.3.4.2.4.B Toxicity of Materials Causing Injuries	Clarification needed.	Leave as is, vague, though it is.
Closed	Issue. 22	-> SYS- Missing Sys Spec Reliability Requirements at 1.3.3.4.x	Need to add finalized set of HASS System reliability requirements to requirements baseline.	Requirement SYS.1.3.3 Performance Requirements	Current identified gap in HASS Requirements	Complete
Open	Issue. 23	-> SUBSYS -->> MNS-to-SYS Allocation of Reliability Requirement ... addressing Essential	MNS states Reliability requirement in terms of "Essential Functional" Failures within the system. System Specification states Reliability requirement in terms of failures of the whole system.	Requirement SYS.1.3.3.4.1 HASS Reliability Constraint	Intent is to be responsive to the MNS	MNS will not be adjusted.. Instead, the Capstone team will make the stated

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
		Functional Failures				assumptions and defer the analysis until a later phase of the project
Open	Issue. 24	-> SYS-FUNC - Missing Requirement(s) for Shelter Insulation/Temperature Regulation	Functional Analysis identifies a functions for + Insulate Inhabitants (i.e. from Cold/Heat) + Temperature Regulation However, System Specification has limited associated requirements (limited to ventilation).	Function A.1.2.1.2.1.1 Insulate Habitants Function A.1.2.1.2.1.3 Maintain Habitable Internal Temperature Requirement SYS.1.3.2 Environmental Operating Conditions Requirement SYS.1.3.4.1 HASS Shelter Capability Requirement SYS.1.3.4.15.A HASS Safety for Occupants	Need ability to regulate internal shelter temperature.	Tabled. Thermal performance = TBD. Additional testing of prototype solution needed. --> To be addressed in a follow-on phase of project.
Closed	Issue. 25	-> SYS-FUNC - No Requirements for System Disposal	HASS Functional Analysis declares that System Disposal is one of three major functions. However, the HASS System Specification has no requirements for System Disposal.	Function A.1.3 Dispose	Need to be consistent between Functional Analysis , which describes what the	Tabled. There are no stakeholder requirements for disposal. Assumption is that the HASS will

Issue Status	Issue #	Issue Name	Issue Description	Associated Requirements/ Functions	Assumptions	Decision
					system is supposed to be used through its lifecycle, AND System Specification, which identifies requirements for what the system shall do.	be disposed IAW with "local" environmental laws and regulations.

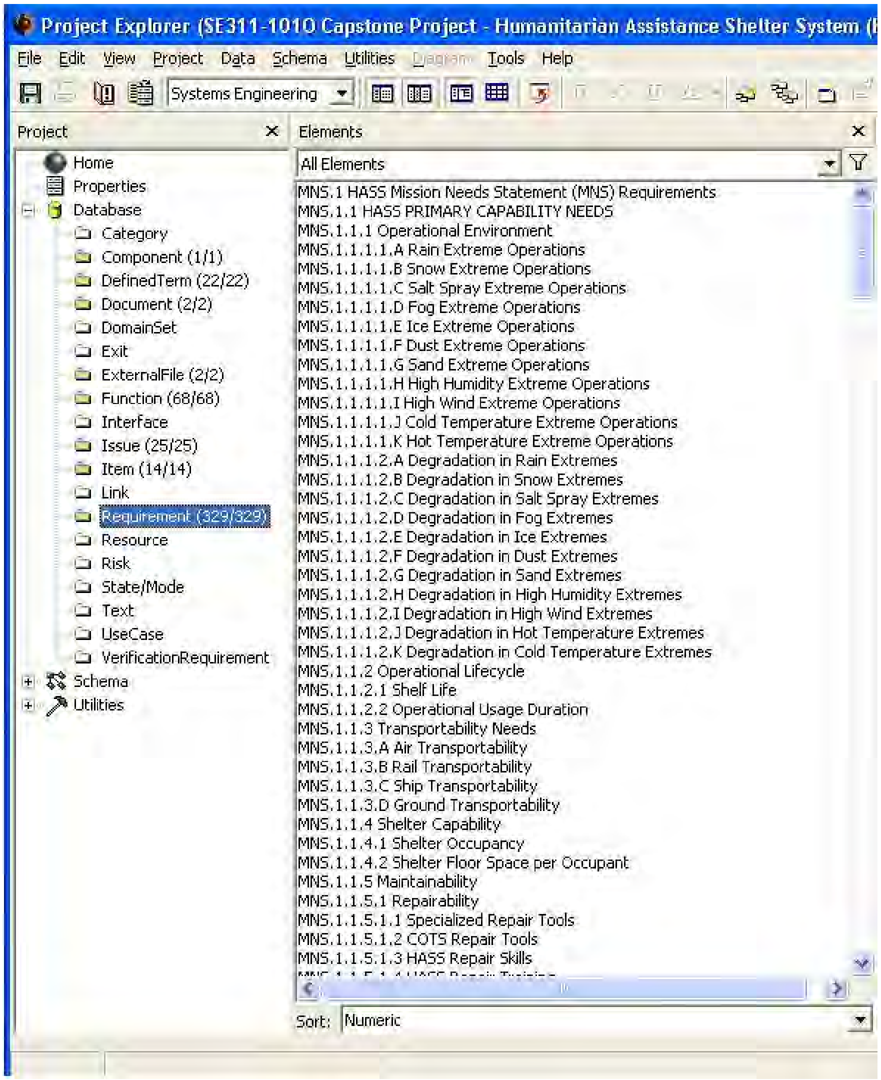
APPENDIX L: CORE DATABASE FILE

The below file is a “Full Repository Backup” XML file for the Capstone Team 311-101O Project for the Humanitarian Aid Shelter System (HASS).

SE311-101O
Capstone Project - H

The file may be imported into the CORE version 7. To access it, pull the file on to the desktop, launch the application and import the file into an empty CORE 7 repository. Then, select and open it.

To confirm successful import, the following numbers of files should be viewable.



Note: Constraints imposed on the CORE University edition product are too tight to accommodate the volume of data items in the file.

APPENDIX M: MNS & SYSTEM REQUIREMENTS CORE EXPORT

Appendix M – HASS Mission Needs Statement and HASS System Specification Requirements Export From CORE 7

The below table captures requirements from the HASS Mission Needs Statement and the HASS System Specification. Requirements captured in the table were analyzed, "shredded" to produce atomic-level verifiable requirements, and traced to ensure that the system described at the bottom of the traces is the same as the system described at the top..

Entries in the Requirements Type Column indicate whether stated requirements are Functional (F), Constraints (C) or Performance (P) in nature. Requirements of Type "nil" are section headers for organizational purposes and are not intended to be considered for verification.

Entries in the Rationale column are to provide additional information about associated requirements. Entries were created as deemed appropriate in the analysis process.

Entries in the "Traces Up" column indicate parentage or pedigree.

Entries in the "Traces Down" column indicate child requirements, which follow or flow from the requirement stated in the row.

Entries in the "Issues Generated" identify numbers and names of issues that were identified in CORE during the requirements analysis. All but two issues are resolved; remaining open issues require a follow-on stage of development to be addressed by another Capstone Team.

Entries in the Functional Links column indicate traceability into the described functional analysis. Purpose of linking functional analysis is to ensure that stated requirements are indeed complete.

At the end of the table are placeholders for capture of requirements to be allocated or partitioned from System-level requirements in a follow-on stage of development by another Capstone Team.

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
MNS.1	HASS Mission Needs Statement (MNS) Requirements	This Mission Need Statement for the Humanitarian Assistance Shelter supports the Naval Post Graduate School Capstone Project Guidance for 311-101O dated Jan 14, 2011. A capability gap exists in humanitarian shelters as there is not a prepackaged system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3 years). In order to support the future U.S Government humanitarian mission, a transition shelter is needed that is transportable, protective,	nil			Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS Requirement SYS.1 HASS System		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		adequately sized, reliable, maintainable, compatible with basic services, designed for an operational lifecycle of at least 2.5 years, securable, and private. In the last ten years, a number of large natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, shelter and medical care have been lost and become critical needs for survival. The United States Government is often a first responder in these events. To serve the needs of displaced victims of disaster, the HASS must deploy a shelter which can protect its occupants and serve their basic needs. Deployment includes set-up by untrained users with the assistance of locally-operating Non-Governmental Organizations. The shelter may be connected to other shelters in order to accommodate larger families or other flexible uses. Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used. Finally, the shelter system must be storable for long periods, and must be palletized for transport by land, air, or sea. Once deployed, the shelter must interface with it's occupants, the environment, and possibly other connected shelters.						
MNS.1.1	HASS PRIMARY CAPABILITY	PRIMARY CAPABILITY NEEDS	nil		Requirement MNS.1 HASS Mission Needs Statement (MNS) Requirements	Requirement MNS.1.1.1 Operational Environment Requirement MNS.1.1.2 Operational Lifecycle		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	NEEDS					Requirement MNS.1.1.3 Transportability Needs Requirement MNS.1.1.4 Shelter Capability Requirement MNS.1.1.5 Maintainability Requirement MNS.1.1.6 Reliability		
MNS.1.1.1	Operational Environment	The shelter solution shall be capable of operations in climatic conditions including rain, snow, salt spray, fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes. Capabilities of the shelter solution shall not be degraded when exposed to climatic conditions.	nil		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.1.B Snow Extreme Operations Requirement MNS.1.1.1.1.C Salt Spray Extreme Operations Requirement MNS.1.1.1.1.D Fog Extreme Operations Requirement MNS.1.1.1.1.E Ice Extreme Operations Requirement MNS.1.1.1.1.F Dust Extreme Operations Requirement MNS.1.1.1.1.G Sand Extreme Operations Requirement MNS.1.1.1.1.H High Humidity Extreme Operations Requirement MNS.1.1.1.1.I High Wind Extreme Operations Requirement MNS.1.1.1.1.J Cold Temperature Extreme Operations Requirement MNS.1.1.1.1.K Hot Temperature Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement MNS.1.1.1.2.B Degradation in Snow Extremes Requirement MNS.1.1.1.2.C Degradation in Salt Spray Extremes Requirement MNS.1.1.1.2.D Degradation in Fog Extremes Requirement MNS.1.1.1.2.E Degradation in Ice Extremes Requirement MNS.1.1.1.2.F Degradation in Dust Extremes Requirement		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						MNS.1.1.1.2.G Degradation in Sand Extremes Requirement MNS.1.1.1.2.H Degradation in High Humidity Extremes Requirement MNS.1.1.1.2.I Degradation in High Wind Extremes Requirement MNS.1.1.1.2.J Degradation in Hot Temperature Extremes Requirement MNS.1.1.1.2.K Degradation in Cold Temperature Extremes Requirement SYS.1.3.3.5 Operation After Vibration Exposure Requirement SYS.1.3.3.6.2 High Altitude Operation Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures Requirement SYS.1.3.4.15.1 HASS Vibration Safety During Operation		
MNS.1.1.1.1.A	Rain Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including rain extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.2 Rain Requirement SYS.1.3.2.3 Sand Conditions Requirement SYS.1.3.2.7.A Operation with Fungus Requirement SYS.1.3.2.8.A Operation & Degradation by Mold Requirement SYS.1.3.2.8.B COTS Mold Resistance Requirement SYS.1.3.2.9.A Operation & Degradation by Mildew Requirement SYS.1.3.2.9.B COTS Mildew Resistance Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.1.B	Snow Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including snow extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.11 Snow Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.1.C	Salt Spray Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including salt spray extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.12 Salt Fog Requirement SYS.1.3.3.3 HASS Water-Resistance	Issue Issue.12 -> MNS Salt	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
							Spray trace to SYS Salt Fog	
MNS.1.1.1.1.D	Fog Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including fog extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.12 Salt Fog Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.1.E	Ice Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including ice extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.5 Icing Conditions Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.1.F	Dust Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including dust extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.4 Dust Conditions		
MNS.1.1.1.1.G	Sand Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including sand extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.3 Sand Conditions		
MNS.1.1.1.1.H	High Humidity Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including high humidity extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.6 Humidity Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.1.I	High Wind Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including high wind extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.10 Wind		
MNS.1.1.1.1.J	Cold Temperature Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including cold temperature extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.1 Temperature		
MNS.1.1.1.1.K	Hot Temperature Extreme Operations	The shelter solution shall be capable of operations in climatic conditions including hot temperature extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.1 Temperature		
MNS.1.1.1.2.A	Degradation in Rain Extremes	Capabilities of the shelter solution shall not be degraded when exposed to rain extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.2 Rain Requirement SYS.1.3.2.3 Sand Conditions Requirement SYS.1.3.2.7.B Degradation by Fungus Requirement SYS.1.3.2.8.A Operation & Degradation by Mold Requirement SYS.1.3.2.8.B COTS Mold Resistance Requirement SYS.1.3.2.9.A Operation & Degradation by Mildew Requirement SYS.1.3.2.9.B COTS Mildew		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Resistance Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.2.B	Degradation in Snow Extremes	Capabilities of the shelter solution shall not be degraded when exposed to snow extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.11 Snow Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.2.C	Degradation in Salt Spray Extremes	Capabilities of the shelter solution shall not be degraded when exposed to salt spray extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.12 Salt Fog Requirement SYS.1.3.3.3 HASS Water-Resistance	Issue Issue.12 -> MNS Salt Spray trace to SYS Salt Fog	
MNS.1.1.1.2.D	Degradation in Fog Extremes	Capabilities of the shelter solution shall not be degraded when exposed to fog extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.12 Salt Fog Requirement SYS.1.3.3.3 HASS Water-Resistance	Issue Issue.13 -> SYS - Missing HASS Fog Environmental Requirement in System Specification	
MNS.1.1.1.2.E	Degradation in Ice Extremes	Capabilities of the shelter solution shall not be degraded when exposed to ice extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.5 Icing Conditions Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.2.F	Degradation in Dust Extremes	Capabilities of the shelter solution shall not be degraded when exposed to dust extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.4 Dust Conditions		
MNS.1.1.1.2.G	Degradation in Sand Extremes	Capabilities of the shelter solution shall not be degraded when exposed to sand extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.3 Sand Conditions		
MNS.1.1.1.2.H	Degradation in High Humidity Extremes	Capabilities of the shelter solution shall not be degraded when exposed to high humidity extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.6 Humidity Requirement SYS.1.3.3.3 HASS Water-Resistance		
MNS.1.1.1.2.I	Degradation in High Wind Extremes	Capabilities of the shelter solution shall not be degraded when exposed to high wind extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.10 Wind		
MNS.1.1.1.2.J	Degradation in Hot Temperature Extremes	Capabilities of the shelter solution shall not be degraded when exposed to hot temperature extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.1 Temperature		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
MNS.1.1.1.2.K	Degradation in Cold Temperature Extremes	Capabilities of the shelter solution shall not be degraded when exposed to cold temperature extremes.	C		Requirement MNS.1.1.1 Operational Environment	Requirement SYS.1.3.2.1 Temperature		
MNS.1.1.2	Operational Lifecycle	The HASS shall survive a shelf life in accordance with MNS.1.2.10 of this Specification. The HASS system shall survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed. Operational duration is defined as any time outside of shelf time.	nil		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement MNS.1.1.2.1 Shelf Life Requirement MNS.1.1.2.2 Operational Usage Duration Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures	Issue Issue.1 -> MNS - Redundant Shelf Life Requirement	
MNS.1.1.2.1	Shelf Life	The HASS shall survive a shelf life in accordance with Section MNS.1.2.10 of this Specification.	C		Requirement MNS.1.1.2 Operational Lifecycle	Requirement SYS.1.3.3.7.1 HASS Long Term Storage Duration Requirement SYS.1.3.3.7.2 HASS Long Term Storage Provisioning		
MNS.1.1.2.2	Operational Usage Duration	The HASS system shall survive an operational usage for duration of 2.5 years (Threshold) and 5 years (Objective) once deployed. Operational duration is defined as any time outside of shelf time.	P		Requirement MNS.1.1.2 Operational Lifecycle	Requirement SYS.1.3.3.1 HASS Operational Lifecycle		
MNS.1.1.3	Transportability Needs	The shelter solution shall be able to be transported on standard military transportation including air, rail, ship and ground transport utilizing a standard pallet.	nil		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability		
MNS.1.1.3.A	Air Transportability	The shelter solution shall be able to be transported on standard military transportation including air transport utilizing a standard pallet.	C		Requirement MNS.1.1.3 Transportability Needs	Requirement SYS.1.3.3.6.1 High Altitude Transport Requirement SYS.1.3.4.5.1 Transportation Configuration Requirement SYS.1.3.4.5.1.1.A Forklift into Standard Shipping Containers Requirement SYS.1.3.4.5.1.1.B Forklift out of Standard Shipping Containers Requirement SYS.1.3.4.5.A HASS Container Transport Requirement SYS.1.3.4.5.B HASS Tie-Down for Transport Requirement SYS.1.3.4.5.C.1		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						HASS Transport Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation		
MNS.1.1.3.B	Rail Transportability	The shelter solution shall be able to be transported on standard military transportation including rail transport utilizing a standard pallet.	C		Requirement MNS.1.1.3 Transportability Needs	Requirement SYS.1.3.4.5.1 Transportation Configuration Requirement SYS.1.3.4.5.1.1.A Forklift into Standard Shipping Containers Requirement SYS.1.3.4.5.1.1.B Forklift out of Standard Shipping Containers Requirement SYS.1.3.4.5.A HASS Container Transport Requirement SYS.1.3.4.5.B HASS Tie-Down for Transport Requirement SYS.1.3.4.5.C.1 HASS Transport Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation		
MNS.1.1.3.C	Ship Transportability	The shelter solution shall be able to be transported on standard military transportation including ship transport utilizing a standard pallet.	C		Requirement MNS.1.1.3 Transportability Needs	Requirement SYS.1.3.4.5.1 Transportation Configuration Requirement SYS.1.3.4.5.1.1.A Forklift into Standard Shipping Containers Requirement SYS.1.3.4.5.1.1.B Forklift out of Standard Shipping Containers Requirement SYS.1.3.4.5.A HASS Container Transport Requirement SYS.1.3.4.5.B HASS Tie-Down for Transport Requirement SYS.1.3.4.5.C.1 HASS Transport Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation		
MNS.1.1.3.D	Ground Transportability	The shelter solution shall be able to be transported on standard military transportation including ground transport utilizing a standard pallet.	C		Requirement MNS.1.1.3 Transportability Needs	Requirement SYS.1.3.4.5.1 Transportation Configuration Requirement SYS.1.3.4.5.1.1.A Forklift into Standard Shipping Containers Requirement SYS.1.3.4.5.1.1.B Forklift out of Standard Shipping Containers Requirement SYS.1.3.4.5.A		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						HASS Container Transport Requirement SYS.1.3.4.5.B HASS Tie-Down for Transport Requirement SYS.1.3.4.5.C.1 HASS Transport Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation Requirement SYS.1.3.4.15.5.2 Forklift Use to Move HASS		
MNS.1.1.4	Shelter Capability	The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective). The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant.	nil		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement MNS.1.1.4.1 Shelter Occupancy Requirement MNS.1.1.4.2 Shelter Floor Space per Occupant Requirement SYS.1.3.3.8 HASS Assembly Requirement SYS.1.3.3.8.A HASS Assembly General Purpose Tools Requirement SYS.1.3.3.8.B HASS Assembly Special Tools Requirement SYS.1.3.3.8.C HASS COTS Assembly Tools Requirement SYS.1.3.3.8.D HASS Assembly Tools Training Requirement SYS.1.3.3.8.E HASS Assembly Skills Requirement SYS.1.3.3.9 HASS Operation Skills		
MNS.1.1.4.1	Shelter Occupancy	The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective).	P		Requirement MNS.1.1.4 Shelter Capability	Requirement SYS.1.3.4.1.1 HASS Shelter Occupancy		
MNS.1.1.4.2	Shelter Floor Space per Occupant	The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant.	P		Requirement MNS.1.1.4 Shelter Capability	Requirement SYS.1.3.4.1.2 HASS Occupancy Floor Space		
MNS.1.1.5	Maintainability	All corrective maintenance shall be performed utilizing supplied general purpose tools.	C		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement MNS.1.1.5.1 Repairability Requirement MNS.1.1.5.1.1 Specialized Repair Tools Requirement MNS.1.1.5.1.2 COTS Repair Tools Requirement MNS.1.1.5.1.3 HASS Repair Skills Requirement MNS.1.1.5.1.4 HASS Repair Training Requirement		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						MNS.1.1.5.1.5 HASS Repair Materials Inclusive Requirement SYS.1.3.3.4.2 Preventive Maintenance in Storage Requirement SYS.1.3.3.4.3 Preventive Maintenance in Operations Requirement SYS.1.3.3.4.4.1 Corrective Maintenance Tools Requirement SYS.1.3.3.4.5 Mean Time Between Maintenance Requirement SYS.1.3.3.4.6 Mean Active Maintenance Time Requirement SYS.1.3.3.4.B.1 Preventive Maintainability Requirement SYS.1.3.3.4.B.2 Corrective Maintainability		
MNS.1.1.5.1	Repairability	HASS shall be designed to require no specialized tools for repairs. All tools required to make repairs shall be COTS. Tools necessary to perform the required repair tasks shall require no specialized training. Any repairs shall be performed by an untrained adult. Materials necessary for repair shall be included in the HASS.	nil		Requirement MNS.1.1.5 Maintainability			
MNS.1.1.5.1.1	Specialized Repair Tools	HASS shall be designed to require no specialized tools for repairs.	C		Requirement MNS.1.1.5 Maintainability	Requirement SYS.1.3.3.4.4.2 Corrective Maintenance Specialized Tools		
MNS.1.1.5.1.2	COTS Repair Tools	All tools required to make repairs shall be COTS.	C		Requirement MNS.1.1.5 Maintainability	Requirement SYS.1.3.3.4.4.3 Corrective Maintenance COTS Tools		
MNS.1.1.5.1.3	HASS Repair Skills	Tools necessary to perform the required repair tasks shall require no specialized training.	C		Requirement MNS.1.1.5 Maintainability	Requirement SYS.1.3.3.4.4.4 Corrective Maintenance Skills		
MNS.1.1.5.1.4	HASS Repair Training	Tools necessary to perform the required repair tasks shall require no specialized training.	C		Requirement MNS.1.1.5 Maintainability	Requirement SYS.1.3.3.4.4.5 Corrective Maintenance Training		
MNS.1.1.5.1.5	HASS Repair Materials Inclusive	Materials necessary for repair shall be included in the HASS.	C		Requirement MNS.1.1.5 Maintainability	Requirement SYS.1.3.3.4.4.6 Corrective Maintenance Materials Inclusive		
MNS.1.1.6	Reliability	The HASS shall demonstrate a mean time between essential functional failures of not less than 21,900 hours (2.5 years) for 95%	P		Requirement MNS.1.1 HASS PRIMARY CAPABILITY NEEDS	Requirement SYS.1.3.3.4.1 HASS Reliability Constraint Requirement SYS.1.3.3.4.A	Issue Issue.2 -> MNS - Use of	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		(Threshold) and 99% (Objective) of shelters with a lower bound 90% confidence interval. An essential functional failure is a failure of certain major components or systems of the HASS that cannot be repaired by the user. Major components are defined as any component in which a failure leads to the shelter being uninhabitable.				HASS Reliability	Phrase "..of Shelters" in Reliability requirement Issue Issue.3 -> MNS - Use of Phrase "..or systems" in Essential Functional Failures definition with Reliability Requirement	
MNS.1.2	HASS SECONDARY CAPABILITY NEEDS	SECONDARY CAPABILITY NEEDS	nil		Requirement MNS.1 HASS Mission Needs Statement (MNS) Requirements	Requirement MNS.1.2.1 Operating Terrain Requirement MNS.1.2.2 Food Preparation, Storage and Distribution Requirement MNS.1.2.3 Communications Requirement MNS.1.2.4 Lighting Requirement MNS.1.2.5 Water Purification, Storage and Distribution Requirement MNS.1.2.6 Security Requirement MNS.1.2.7 Safety Requirement MNS.1.2.8 Human Engineering Requirement MNS.1.2.9 Materials Requirement MNS.1.2.10 Long Term Storage Needs Requirement MNS.1.2.11 Occupant Privacy		
MNS.1.2.1	Operating Terrain	The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized (Objective). The system shall be able to operate on a surface with a 12" slope over the 20' length (Threshold).	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.1.1 Terrain Adaptability Requirement MNS.1.2.1.2.A HASS Shelter Leveling Requirement MNS.1.2.1.2.B HASS Shelter Stabilizing Requirement MNS.1.2.1.3 HASS Operation of Uneven Terrain		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
MNS.1.2.1.1	Terrain Adaptability	The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces.	C		Requirement MNS.1.2.1 Operating Terrain	Requirement SYS.1.3.3.2.1 HASS Operating Terrain Variance		
MNS.1.2.1.2.A	HASS Shelter Leveling	The HASS shall be capable of being leveled (Objective).	C		Requirement MNS.1.2.1 Operating Terrain	Requirement SYS.1.3.3.2.2.A Leveling HASS on Operating Terrain		
MNS.1.2.1.2.B	HASS Shelter Stabilizing	The HASS shall be capable of being stabilized (Objective).	C		Requirement MNS.1.2.1 Operating Terrain	Requirement SYS.1.3.3.2.2.B Stabilizing HASS on Operating Terrain		
MNS.1.2.1.3	HASS Operation of Uneven Terrain	The system shall be able to operate on a surface with a 12" slope over the 20' length (Threshold).	P		Requirement MNS.1.2.1 Operating Terrain	Requirement SYS.1.3.3.2.3 HASS Operating Slope		
MNS.1.2.2	Food Preparation, Storage and Distribution	The Human Assistance Shelter System shall equip occupant(s) with resources for food preparation (Objective), distribution (Objective) and storage (Threshold). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption.	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.2.1 HASS Food Preparation Requirement MNS.1.2.2.2 HASS Food Distribution Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures		
MNS.1.2.2.1	HASS Food Preparation	The Human Assistance Shelter System shall equip occupant(s) with resources for food preparation (Objective).	C		Requirement MNS.1.2.2 Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits Requirement SYS.1.3.4.6.2.1 Food Preparation & Distribution Kit Material Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions Requirement SYS.1.3.4.6.3.1 Food Preparation Equipment Heat Transfer Performance Requirement SYS.1.3.4.6.3.2.A Food Preparation Equipment Surface Area Performance Requirement SYS.1.3.4.6.3.2.B.1 Food Preparation Equipment Cooking Time Requirement SYS.1.3.4.6.3.2.B.2 Food Preparation Equipment Cooking		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Recovery Time Requirement SYS.1.3.4.6.3.3 Food Preparation Equipment Cooking Surface Material Requirement SYS.1.3.4.6.3.4 Food Preparation Equipment Efficiency Requirement SYS.1.3.4.6.A Food Preparation Equipping		
MNS.1.2.2.2	HASS Food Distribution	The Human Assistance Shelter System shall equip occupant(s) with resources for food distribution (Objective). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption.	C		Requirement MNS.1.2.2 Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits Requirement SYS.1.3.4.6.2.1 Food Preparation & Distribution Kit Material Requirement SYS.1.3.4.6.C Food Distribution Equipping		
MNS.1.2.2.3	HASS Food Storage	The Human Assistance Shelter System shall equip occupant(s) with resources for food storage (Threshold).	C		Requirement MNS.1.2.2 Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.1.1 Food Storage Container Volume Requirement SYS.1.3.4.6.1.2 Food Storage Container Quantity Requirement SYS.1.3.4.6.1.A Air-Tight Food Storage Containers Requirement SYS.1.3.4.6.1.B Water-Proof Food Storage Containers Requirement SYS.1.3.4.6.B Food Storage Equipping		
MNS.1.2.3	Communications	HASS shall incorporate provisions for one-way communication (Threshold) and two-way communication (Objective).	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.3.1 One-Way Communications Requirement MNS.1.2.3.2 Two-Way Communications		
MNS.1.2.3.1	One-Way Communications	HASS shall incorporate provisions for one-way communication (Threshold).	C		Requirement MNS.1.2.3 Communications	Requirement SYS.1.3.4.8 HASS Communications		
MNS.1.2.3.2	Two-Way Communications	HASS shall incorporate provisions for two-way communication (Objective).	C		Requirement MNS.1.2.3 Communications	Requirement SYS.1.3.4.8 HASS Communications		
MNS.1.2.4	Lighting	The HASS shall be capable of providing natural light to the internal volume (Threshold). The HASS shall have provisions to adjust the amount of light entering the space. The HASS shall have provisions for artificial lighting (Objective).	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.4.1 HASS Natural Lighting Requirement MNS.1.2.4.2 HASS Natural Lighting Adjustment Requirement MNS.1.2.4.3 HASS Artificial		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Lighting		
MNS.1.2.4.1	HASS Natural Lighting	The HASS shall be capable of providing natural light to the internal volume (Threshold).	C		Requirement MNS.1.2.4 Lighting	Requirement SYS.1.3.4.9.A Natural Lighting		
MNS.1.2.4.2	HASS Natural Lighting Adjustment	The HASS shall have provisions to adjust the amount of light entering the space.	C		Requirement MNS.1.2.4 Lighting	Requirement SYS.1.3.4.9.B Natural Lighting Adjustment Requirement SYS.1.3.4.9.C Securing HASS Natural Lighting		
MNS.1.2.4.3	HASS Artificial Lighting	The HASS shall have provisions for artificial lighting (Objective).	C		Requirement MNS.1.2.4 Lighting	Requirement SYS.1.3.4.10 Artificial Lighting Requirement SYS.1.3.4.10.1 Artificial Lighting Performance		
MNS.1.2.5	Water Purification, Storage and Distribution	The HASS shall be able to purify indigenous water sources (Objective). The HASS shall have capacity to store water for consumption, personal hygiene and food preparation (Threshold). The HASS shall be capable of dispensing water directly to users for consumption without the loss of any water.	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.5.1 HASS Water Purification Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement MNS.1.2.5.3 HASS Water Dispensing Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures		
MNS.1.2.5.1	HASS Water Purification	The HASS shall be able to purify indigenous water sources (Objective).	C		Requirement MNS.1.2.5 Water Purification, Storage and Distribution	Requirement SYS.1.3.4.7.1 Water Purification Temperature Requirement SYS.1.3.4.7.2 Water Purification Rate Requirement SYS.1.3.4.7.3.A Water Purification Quality IAW NSF P231 Requirement SYS.1.3.4.7.3.B Water Purification Quality IAW TB-MED 577 (2010) Requirement SYS.1.3.4.7.A Water Purification		
MNS.1.2.5.2.A	HASS Water Storage for Consumption	The HASS shall have capacity to store water for consumption (Threshold).	C		Requirement MNS.1.2.5 Water Purification, Storage and Distribution	Requirement SYS.1.3.4.7.4.A HASS Water Storage Volume Requirement SYS.1.3.4.7.4.B Separate HASS Water Storage Volume per Occupant Requirement SYS.1.3.4.7.5.A		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Water Storage Weight Requirement SYS.1.3.4.7.6.A Water Storage Sealability Requirement SYS.1.3.4.7.6.B Water Storage Exposure to BPA Requirement SYS.1.3.4.7.6.C Water Storage Construction Exposure Requirement SYS.1.3.4.7.B Water Storage		
MNS.1.2.5.2.B	HASS Water Storage for Personal Hygiene	The HASS shall have capacity to store water for personal hygiene (Threshold).	C		Requirement MNS.1.2.5 Water Purification, Storage and Distribution	Requirement SYS.1.3.4.7.4.A HASS Water Storage Volume Requirement SYS.1.3.4.7.4.B Separate HASS Water Storage Volume per Occupant Requirement SYS.1.3.4.7.5.A Water Storage Weight Requirement SYS.1.3.4.7.6.A Water Storage Sealability Requirement SYS.1.3.4.7.6.B Water Storage Exposure to BPA Requirement SYS.1.3.4.7.6.C Water Storage Construction Exposure Requirement SYS.1.3.4.7.B Water Storage		
MNS.1.2.5.2.C	HASS Water Storage for Food Preparation	The HASS shall have capacity to store water for food preparation (Threshold).	C		Requirement MNS.1.2.5 Water Purification, Storage and Distribution	Requirement SYS.1.3.4.7.4.A HASS Water Storage Volume Requirement SYS.1.3.4.7.4.B Separate HASS Water Storage Volume per Occupant Requirement SYS.1.3.4.7.5.A Water Storage Weight Requirement SYS.1.3.4.7.6.A Water Storage Sealability Requirement SYS.1.3.4.7.6.B Water Storage Exposure to BPA Requirement SYS.1.3.4.7.6.C Water Storage Construction Exposure Requirement SYS.1.3.4.7.B Water Storage		
MNS.1.2.5.3	HASS Water Dispensing	The HASS shall be capable of dispensing water directly to users for consumption without the loss of any water.	C		Requirement MNS.1.2.5 Water Purification, Storage and Distribution	Requirement SYS.1.3.4.7.5.B Water Distribution Weight Requirement SYS.1.3.4.7.7 Water Storage Distribution Requirement SYS.1.3.4.7.C		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Water Distribution		
MNS.1.2.6	Security	The HASS shall be securable against intruders (Objective).	C		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement SYS.1.3.4.9.C Securing HASS Natural Lighting Requirement SYS.1.3.4.9.D Secured Natural Lighting Opaque Requirement SYS.1.3.4.15.10 HASS Security		
MNS.1.2.7	Safety	The HASS shall protect occupants and minimize exposure of the users, maintenance and handling personnel to safety hazards during its use, storage, and transport. The HASS shall include warning labels/indicators to warn of hazards. The HASS components shall be identified and located to prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death. The HASS shall provide occupants protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g snakes, scorpions, rats, mosquitoes).	nil	Regarding the first sentence. Other permutations in decomposing this complexly stated requirement exist but are not intended. The only ones intended are listed as children to 1.2.7.1.	Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.7.1.A Occupant Protection During Use Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement MNS.1.2.7.3.A Component Identification Requirement MNS.1.2.7.3.B Component Location Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.14.2 Emergency Egress Time Requirement SYS.1.3.4.15.10 HASS Security		
MNS.1.2.7.1.A	Occupant Protection During Use	The HASS shall protect occupants from safety hazards during its use.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.A HASS Safety for Occupants		
MNS.1.2.7.1.B	Minimize Hazards to	The HASS shall minimize exposure of the users to safety hazards during its use.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.2.4.A Toxicity of Materials to Skin		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Users During Use					Requirement SYS.1.3.4.2.4.B Toxicity of Materials Causing Injuries Requirement SYS.1.3.4.2.4.C Toxicity of Materials Causing Vapor Hazards Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits Requirement SYS.1.3.4.15.A HASS Safety for Occupants		
MNS.1.2.7.1.C	Minimize Hazards to Maintainers During Use	The HASS shall minimize exposure of the maintenance personnel to safety hazards during its use.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.3.4.3 Preventive Maintenance in Operations Requirement SYS.1.3.3.4.4.1 Corrective Maintenance Tools Requirement SYS.1.3.3.4.4.2 Corrective Maintenance Specialized Tools Requirement SYS.1.3.3.4.4.3 Corrective Maintenance COTS Tools Requirement SYS.1.3.3.4.4.4 Corrective Maintenance Skills Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.7 Unsafe Conditions during Maintenance Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits Requirement SYS.1.3.4.15.B HASS Safety for		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Maintainers		
MNS.1.2.7.1.D	Minimize Hazards to Maintainers During Storage	The HASS shall minimize exposure of the maintenance personnel to safety hazards during its storage.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.3.4.2 Preventive Maintenance in Storage Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.C HASS Storage Safety of Maintenance Personnel Requirement SYS.1.3.4.15.B HASS Safety for Maintainers		
MNS.1.2.7.1.E	Minimize Hazards to Maintainers During Transport	The HASS shall minimize exposure of the maintenance personnel to safety hazards during its transport.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.D HASS Transport Safety of Maintenance Personnel Requirement SYS.1.3.4.15.B HASS Safety for Maintainers		
MNS.1.2.7.1.F	Minimize Hazards to Handling Personnel During Storage	The HASS shall minimize exposure of the handling personnel to safety hazards during its storage.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.A HASS		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Storage Safety of Warehouse Personnel Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers		
MNS.1.2.7.1.G	Minimize Hazards to Handling Personnel During Transport	The HASS shall minimize exposure of the handling personnel to safety hazards during its transport.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.B HASS Transport Safety of Warehouse Personnel Requirement SYS.1.3.4.15.5.2 Forklift Use to Move HASS Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers		
MNS.1.2.7.2.A	Warning Labels	The HASS shall include warning labels to warn of hazards.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.8.A HASS Component Location Safety Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers		
MNS.1.2.7.2.B	Warning Indicators	The HASS shall include warning indicators to warn of hazards.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.8.A HASS Component Location Safety Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers		
MNS.1.	Component	The HASS components shall be identified to	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.8.A		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
2.7.3.A	Identification	prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death.				HASS Component Location Safety		
MNS.1.2.7.3.B	Component Location	The HASS components shall be located to prevent injury to users in case of an emergency.	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.8.B Component Location Safety		
MNS.1.2.7.4	Vector-borne Disease Protection	The HASS shall provide occupants protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g snakes, scorpions, rats, mosquitoes).	C		Requirement MNS.1.2.7 Safety	Requirement SYS.1.3.4.15.6.1 Vector-Born Disease Protection Requirement SYS.1.3.4.15.6.2.A HASS Opening Barrier Type I Requirement SYS.1.3.4.15.6.2.B HASS Opening Barrier Type II Requirement SYS.1.3.4.15.6.2.C HASS Opening Barrier Type III Requirement SYS.1.3.4.15.6.2.D HASS Seam Barrier Type I Requirement SYS.1.3.4.15.6.2.E HASS Seam Barrier Type II Requirement SYS.1.3.4.15.6.2.F HASS Seam Barrier Type III Requirement SYS.1.3.4.15.6.2.G HASS Gap Barrier Type I Requirement SYS.1.3.4.15.6.2.H HASS Gap Barrier Type II Requirement SYS.1.3.4.15.6.2.I HASS Gap Barrier Type III		
MNS.1.2.8	Human Engineering	The HASS shall be operable and maintainable by the full range of personnel (5th percentile female through 95th percentile male) in accordance with applicable sections of MIL-STD-1472. The HASS shall ensure adequate clearance for movement, to ingress/egress work area, and perform all required tasks. The HASS components shall be capable of 2 person lift.	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.8.1.A Operability by 5th Percentile Female Requirement MNS.1.2.8.1.B Operability by 95th Percentile Male Requirement MNS.1.2.8.1.C Maintainability by 5th Percentile Female Requirement MNS.1.2.8.1.D Maintainability by 95th Percentile Male Requirement MNS.1.2.8.2.A Clearance for Movement Requirement MNS.1.2.8.2.B	Issue Issue.4 -> MNS - Version of MIL-STD-1472 Issue Issue.5 -> MNS - Use of Phrase "work area"	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Clearance for Ingress/Egress Requirement MNS.1.2.8.2.C Clearance for Task Performance Requirement MNS.1.2.8.3 Two Person Lift		
MNS.1.2.8.1.A	Operability by 5th Percentile Female	The HASS shall be operable by the full range of personnel [including the] 5th percentile female in accordance with applicable sections of MIL-STD-1472.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress Requirement SYS.1.3.4.14.A HASS Human Factors Operability		
MNS.1.2.8.1.B	Operability by 95th Percentile Male	The HASS shall be operable by the full range of personnel [including the] 95th percentile male in accordance with applicable sections of MIL-STD-1472.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress Requirement SYS.1.3.4.14.A HASS Human Factors Operability		
MNS.1.2.8.1.C	Maintainability by 5th Percentile Female	The HASS shall be maintainable by the full range of personnel [including the] 5th percentile female in accordance with applicable sections of MIL-STD-1472.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability		
MNS.1.2.8.1.D	Maintainability by 95th Percentile Male	The HASS shall be operable by the full range of personnel [including the] 95th percentile male in accordance with applicable sections of MIL-STD-1472.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability		
MNS.1.2.8.2.A	Clearance for Movement	The HASS shall ensure adequate clearance for movement.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Requirement SYS.1.3.4.14.1.A HASS Spacial Clearance for Movement		
MNS.1.2.8.2.B	Clearance for Ingress/Egress	The HASS shall ensure adequate clearance to ingress/egress work area.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress Requirement SYS.1.3.4.14.1.B HASS Spacial Clearance for Ingress/Egress		
MNS.1.2.8.2.C	Clearance for Task Performance	The HASS shall ensure adequate clearance to perform all required tasks.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.14.1.C HASS Spacial Clearance for Task Performance		
MNS.1.2.8.3	Two Person Lift	The HASS components shall be capable of 2 person lift.	C		Requirement MNS.1.2.8 Human Engineering	Requirement SYS.1.3.4.14.3.A Inseparable Assembly Weight Requirement SYS.1.3.4.14.3.B Separable Assembly Weight		
MNS.1.2.9	Materials	HASS shall not contain any materials hazardous to the occupant's health and environment in accordance with applicable National Environmental Protection Agency (NEPA) or international standards. Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice. All components of the HASS shall utilize recycled, recovered, or environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs. HASS shall be designed as to preclude use of any flammable materials. Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F.	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement MNS.1.2.9.2 Ozone Depletion Prevention Requirement MNS.1.2.9.3 Ozone Resistant Rubber Requirement MNS.1.2.9.4.A Use of Recycled Materials Requirement MNS.1.2.9.4.B Use of Recovered Materials Requirement MNS.1.2.9.4.C Use of Environmentally Preferable Materials Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement MNS.1.2.9.6 Use	Issue Issue.6 -> MNS - Insufficient NEPA Standard Identification Issue Issue.7 -> MNS - Insufficient International Standard Identification Issue Issue.8 -> MNS - Insufficient Federal Regulations Identification Issue Issue.9 -> MNS - COTS vs. recycled, recovered, or environmentally preferable materials	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						of Combustible Materials		
MNS.1.2.9.1.A	Materials Hazardous to Health per NEPA	HASS shall not contain any materials hazardous to the occupant's health in accordance with National Environmental Protection Agency (NEPA) standards.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.4.A Toxicity of Materials to Skin Requirement SYS.1.3.4.2.4.B Toxicity of Materials Causing Injuries Requirement SYS.1.3.4.2.4.C Toxicity of Materials Causing Vapor Hazards Requirement SYS.1.3.4.2.A.1 HASS Class A Health Hazardous Materials Requirement SYS.1.3.4.2.A.2 HASS Class C Health Hazardous Materials Requirement SYS.1.3.4.2.A.3 HASS Class D Health Hazardous Materials Requirement SYS.1.3.4.2.A.4 HASS Class E Health Hazardous Materials Requirement SYS.1.3.4.2.A.5 HASS Class F Health Hazardous Materials Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits	Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
MNS.1.2.9.1.B	Materials Hazardous to Environment per NEPA	HASS shall not contain any materials hazardous to the occupant's health in accordance with National Environmental Protection Agency (NEPA) standards.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.A.6 HASS Class A Environment Hazardous Materials Requirement SYS.1.3.4.2.A.7 HASS Class C Environment Hazardous Materials Requirement SYS.1.3.4.2.A.8 HASS Class D Environment Hazardous Materials Requirement SYS.1.3.4.2.A.9 HASS Class E Environment Hazardous Materials Requirement SYS.1.3.4.2.A.10 HASS Class F Environment Hazardous Materials	Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
MNS.1.2.9.1.C	Materials Hazardous to Health per International	HASS shall not contain any materials hazardous to the occupant's health in accordance with international standards.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.4.A Toxicity of Materials to Skin Requirement SYS.1.3.4.2.4.B Toxicity of Materials Causing Injuries Requirement SYS.1.3.4.2.4.C Toxicity of	Issue Issue.18 -> MNS Hazardous Materials Rqmts do not	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Standards					Materials Causing Vapor Hazards Requirement SYS.1.3.4.2.A.1 HASS Class A Health Hazardous Materials Requirement SYS.1.3.4.2.A.2 HASS Class C Health Hazardous Materials Requirement SYS.1.3.4.2.A.3 HASS Class D Health Hazardous Materials Requirement SYS.1.3.4.2.A.4 HASS Class E Health Hazardous Materials Requirement SYS.1.3.4.2.A.5 HASS Class F Health Hazardous Materials Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits	appear to trace to SYS SPEC Hazardous Materials Requirements	
MNS.1.2.9.1.D	Materials Hazardous to Environment per International Standards	HASS shall not contain any materials hazardous to the environment in accordance with international standards.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.A.6 HASS Class A Environment Hazardous Materials Requirement SYS.1.3.4.2.A.7 HASS Class C Environment Hazardous Materials Requirement SYS.1.3.4.2.A.8 HASS Class D Environment Hazardous Materials Requirement SYS.1.3.4.2.A.9 HASS Class E Environment Hazardous Materials Requirement SYS.1.3.4.2.A.10 HASS Class F Environment Hazardous Materials	Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
MNS.1.2.9.2	Ozone Depletion Prevention	Components of the HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.B HASS Ozone Depleting Substances		
MNS.1.2.9.3	Ozone Resistant Rubber	All rubber products utilized shall be ozone resistant consistent with best commercial practice.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.C HASS Ozone Resistant Materials		
MNS.1.2.9.4.A	Use of Recycled Materials	All components of the HASS shall utilize recycled materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.1.A HASS Modification with Recycled Materials Requirement SYS.1.3.4.2.1.C HASS Modification with Locally Available Materials		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
MNS.1.2.9.4.B	Use of Recovered Materials	All components of the HASS shall utilize recovered materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.1.B HASS Modification with Recovered Materials Requirement SYS.1.3.4.2.1.C HASS Modification with Locally Available Materials		
MNS.1.2.9.4.C	Use of Environmentally Preferable Materials	All components of the HASS shall utilize environmentally preferable materials to the maximum extent possible, provided that the material promotes economically advantageous life cycle costs.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.1.C HASS Modification with Locally Available Materials Requirement SYS.1.3.4.2.1.D HASS Modification with Environmentally Preferable Materials		
MNS.1.2.9.5	Use of Flamable Materials	HASS shall be designed as to preclude use of any flammable materials. Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.3.A.1 Flammable Liquids Use per OSHA 1926.152 Class 1A Requirement SYS.1.3.4.2.3.A.2 Flammable Liquids Use per OSHA 1926.152 Class 1B Requirement SYS.1.3.4.2.3.A.3 Flammable Liquids Use per OSHA 1926.152 Class 1C Requirement SYS.1.3.4.2.3.B.1 Flammable Materials Use per OSHA 1926.152 Class 1A Requirement SYS.1.3.4.2.3.B.2 Flammable Materials Use per OSHA 1926.152 Class 1B Requirement SYS.1.3.4.2.3.B.3 Flammable Materials Use per OSHA 1926.152 Class 1C		
MNS.1.2.9.6	Use of Combustible Materials	Any combustible materials shall be treated as to minimize their combustibility. Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F.	C		Requirement MNS.1.2.9 Materials	Requirement SYS.1.3.4.2.5 Treatment and Painting of Materials		
MNS.1.2.10	Long Term Storage Needs	The HASS shall be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Applicable packaging shall be provisioned for long term storage.	nil		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement MNS.1.2.10.1 Long Term Storage Duration Requirement MNS.1.2.10.2 Long Term Storage Packaging		
MNS.1.2.10.1	Long Term Storage Duration	The HASS shall be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity.	P		Requirement MNS.1.2.10 Long Term Storage Needs	Requirement SYS.1.3.3.7.1 HASS Long Term Storage Duration		
MNS.1.	Long Term	Applicable packaging shall be provisioned	C		Requirement MNS.1.2.10 Long	Requirement SYS.1.3.3.7.2		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
2.10.2	Storage Packaging	for long term storage.			Term Storage Needs	HASS Long Term Storage Provisioning		
MNS.1.2.11	Occupant Privacy	The HASS shall have provisions that allow dividing of internal volume for occupant privacy (Threshold = Objective).	C		Requirement MNS.1.2 HASS SECONDARY CAPABILITY NEEDS	Requirement SYS.1.3.4.9.D Secured Natural Lighting Opaque Requirement SYS.1.3.4.11.1 HASS Volume Divider Division Requirement SYS.1.3.4.11.A HASS Occupant Privacy Requirement SYS.1.3.4.11.B HASS Volume Divider Opaque		
MNS.1.3	HASS TERTIARY CAPABILITY NEEDS	TERTIARY CAPABILITY NEEDS	nil		Requirement MNS.1 HASS Mission Needs Statement (MNS) Requirements	Requirement MNS.1.3.1 Ventilation Provisions Requirement MNS.1.3.2 Scalability and Modularity Requirement MNS.1.3.3 Marking Requirement MNS.1.3.4 Color Requirement MNS.1.3.5 Shelter Components		
MNS.1.3.1	Ventilation Provisions	The HASS shall have provisions for natural ventilation (Threshold).	C		Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS	Requirement SYS.1.3.4.11.1 HASS Volume Divider Division Requirement SYS.1.3.4.12 HASS Ventilation Provisions Requirement SYS.1.3.4.12.1 HASS Ventilation Size Requirement SYS.1.3.4.12.2 HASS Ventilation Performance Requirement SYS.1.3.4.12.3.A HASS Ventilation Closure Requirement SYS.1.3.4.12.3.B HASS Ventilation Securing		
MNS.1.3.2	Scalability and Modularity	The HASS shall connect to another of the same type to increase the covered area. It shall be possible to connect the shelters using only the components and tools provided in the standard shelter package.	nil		Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS	Requirement MNS.1.3.2.1 Connecting HASS Shelters Requirement MNS.1.3.2.2 Means for connecting HASS Shelters		
MNS.1.3.2.1	Connecting HASS Shelters	The HASS shall connect to another of the same type to increase the covered area.	C		Requirement MNS.1.3.2 Scalability and Modularity	Requirement SYS.1.3.4.13.A HASS-to-HASS Shelter Connections		
MNS.1.3.2.2	Means for connecting HASS Shelters	It shall be possible to connect the shelters using only the components and tools provided in the standard shelter package.	C		Requirement MNS.1.3.2 Scalability and Modularity	Requirement SYS.1.3.4.13.B.1 Component Means to Connect HASS Shelters Requirement SYS.1.3.4.13.B.2 Tool Means to Connect HASS Shelters		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
MNS.1.3.3	Marking	The HASS shall be marked in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft.	C		Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS	Requirement SYS.1.3.4.4.A HASS Labeling Identification Requirement SYS.1.3.4.4.B HASS Labeling Method		
MNS.1.3.4	Color	Military or camouflage colors shall not be used. Cultural and political sensitivities shall be taken into account, for example in the use of colors used in national or factional flags in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft	nil		Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS	Requirement MNS.1.3.4.1.A Use of Military Colors Requirement MNS.1.3.4.1.B Use of Camouflage Colors Requirement MNS.1.3.4.2.A Cultural Sensitivities in HASS Color Requirement MNS.1.3.4.2.B Political Sensitivities in HASS Color	Issue Issue.10 -> MNS - Insufficient Clarity in Color Requirement Issue Issue.11 -> MNS - Inappropriate Use of an Example in a Requirement	
MNS.1.3.4.1.A	Use of Military Colors	Military colors shall not be used.	C		Requirement MNS.1.3.4 Color	Requirement SYS.1.3.4.3 HASS Shelter Color		
MNS.1.3.4.1.B	Use of Camouflage Colors	Camouflage colors shall not be used.	C		Requirement MNS.1.3.4 Color	Requirement SYS.1.3.4.3 HASS Shelter Color		
MNS.1.3.4.2.A	Cultural Sensitivities in HASS Color	The HASS shelter shall take cultural sensitivities into account. For example, the use of colors used in national or factional flags should not be used in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft.	C		Requirement MNS.1.3.4 Color	Requirement SYS.1.3.4.3 HASS Shelter Color		
MNS.1.3.4.2.B	Political Sensitivities in HASS Color	The HASS shelter shall take political sensitivities into account. For example, the use of colors used in national or factional flags should not be used in accordance with Shelter Centre Transitional Shelter Standards – 2010 – draft.	C		Requirement MNS.1.3.4 Color	Requirement SYS.1.3.4.3 HASS Shelter Color		
MNS.1.3.5	Shelter Components	The HASS shall maximize use of COTS components.	C		Requirement MNS.1.3 HASS TERTIARY CAPABILITY NEEDS	Requirement SYS.1.3.2.8.B COTS Mold Resistance Requirement SYS.1.3.2.9.B COTS Mildew Resistance Requirement SYS.1.3.4.2.2 COTS Material and Component Selection	Issue Issue.9 -> MNS - COTS vs. recycled, recovered, or environmentally preferable	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
							materials	
SYS.1	HASS System	HASS System	nil		Requirement MNS.1 HASS Mission Needs Statement (MNS) Requirements	Requirement SYS.1.1 HASS System Scope, Background and Overview Requirement SYS.1.2 HASS System Applicable Documents Requirement SYS.1.3 REQUIREMENTS		
SYS.1.1	HASS System Scope, Background and Overview	Scope. This system specification defines the performance, design, environmental, and verification requirements for the Humanitarian Assistance Shelter System (HASS). The HASS is a proposed concept intended to provide shelter for disaster victims. The HASS is a transportable, protective, adequately sized, reliable, maintainable, compatible with basic services, and intended for an operational lifecycle of at least 2.5 years, securable, and private system. Background. In the last ten years, a number of large natural disasters have displaced millions of people and eliminated the most basic of amenities. Food, clean water, and shelter have been lost and become critical needs for survival. The United States Government is often a first responder in these events. To serve the needs of displaced victims of disaster, the HASS must deploy and protect its occupants and serve their basic needs. Deployment includes set-up by untrained users with the assistance of locally-operating Non-Governmental Organizations. The shelter may be connected to other shelters in order to accommodate larger families or other flexible uses. System Overview. In order to support possible future U.S Government and NGO humanitarian missions, a transition shelter is needed. A capability gap exists in humanitarian shelters as there is not a universally accepted system that can be stored and then delivered to disaster victims to provide shelter in the transitional period between emergency shelter and permanent housing (approximately 6 months to 3	nil		Requirement SYS.1 HASS System			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		years). Occupants must be protected from a variety of weather conditions (e.g., rain, snow, heat, and dust) and environmental concerns (e.g., insects, rodents, and aftershocks). Basic needs served by the shelter system include food preparation, water and food storage, emergency communication, and minimal lighting. Occupants will live in the shelter, store things in the shelter, and perform simple maintenance on the shelter. Once permanent housing is available, the shelter will be disassembled and discarded. Some components may be salvaged and re-used. Finally, the shelter system must be storable for long periods, and must be palletized for transport by land, air, or sea. Once deployed, the shelter must interface with its occupants, the environment, and possibly other connected shelters.						
SYS.1.2	HASS System Applicable Documents		nil		Requirement SYS.1 HASS System	Requirement SYS.1.2.1 HASS Applicable Documents General Requirement SYS.1.2.2 HASS System Government Documents Requirement SYS.1.2.3 Non-Government Publications Requirement SYS.1.2.4 Order of Precedence		
SYS.1.2.1	HASS Applicable Documents General	The documents listed in this section are specified in Sections 1.2 or 1.3 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Sections 1.2or 1.3 of this specification, whether or not they are listed.	nil		Requirement SYS.1.2 HASS System Applicable Documents			
SYS.1.2.2	HASS System Government		nil		Requirement SYS.1.2 HASS System Applicable Documents	Requirement SYS.1.2.2.1 Specifications, Standards, and Handbooks Requirement SYS.1.2.2.2 Other Government		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Documents					Documents, Drawings, and Publications		
SYS.1.2.2.1	Specifications, Standards, and Handbooks	The following specifications, standards, and handbooks of the exact revision listed below form a part of this document to the extent specified herein. \tDEPARTMENT OF DEFENSE STANDARDS (Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.) MIL-STD-810G\tDepartment of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests MIL-STD-130M\tDepartment of Defense Standard Practice-Identification Marking of U.S. Military Property MIL-STD-1472D\tDepartment of Defense Design Criteria for Human Engineering	C		Requirement SYS.1.2.2 HASS System Government Documents			
SYS.1.2.2.2	Other Government Documents, Drawings, and Publications	The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. FEDERAL STANDARDS (Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.) FED-STD-595C\tColors Used in Government Procurement \t\t US ARMY (Copies of these documents are available online at Army Publishing Directorate (www.apd.army.mil) or Army at Army Knowledge Online (www.us.army.mil)). TB-MED 577 (2010))\tSanitary Control and Surveillance of Field Water Supplies. US ARMY\t\t U.S. Army's 1998 Anthropometric Survey US ARMY \tOperational Forces Interface Group – Vehicular Mounted Combat Cooling System (VMCCS).Natick Soldier	C		Requirement SYS.1.2.2 HASS System Government Documents			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		Research, Development and Engineering Center. Internal Report, January 8, 2009.) NATIONAL SCIENCE FOUNDATION (NSF) (Copies of these documents are available online at http://www.nsf.gov) NSF Protocol 231 \tMicrobiological Water Purifiers \tOCCUPATIONAL SAFETY AND HEALTH ASSOCIATION (OSHA) (Copies of these documents are available online at http://www.osha.gov) OSHA 1926.152\tSafety and Health Regulations for Construction OSHA CFR 29\tOSHA Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 dated 1998						
SYS.1.2.3	Non-Government Publications	The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract. INTERNATIONAL STANDARDS ORGANIZATION (Copies of these documents are available online at http://www.iso.org) \t\tISO 3864-2:2004\tGraphical Symbols-Safety Colors and Signs \t\tISO 1496-1:1990\tStandard for Forklift Pockets AMERICAN NATIONAL STANDARDS INSTITUTE (Copies of these documents are available online at http://www.ansi.org) ANSI/UL 263 (2001) Fire Resistance Ratings \tAMERICAN SOCIETY FOR TESTING AND MEASUREMENT (ASTM) (Copies of these documents are available online at http://www.astm.org) ASTM F-1275-03 \t Standard method for performance of Griddles ASTM D6413-94\tVertical Flame Chamber \t \t \tOXFAM (Copies of these documents are available online at http://publications. oxfam.org.uk) Shelter Project- Transitional Settlement Displaced Populations, 2005 (http://postconflict.unep.ch/liberia/displacement/documents/Corsellis_Vitale_Transitional_Settlement_Displaced_Populatio.pdf)	C		Requirement SYS.1.2 HASS System Applicable Documents			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		\tSHELTER CENTRE Shelter Centre Transitional Shelter Standards Version 10B (2010). \t\tSPHEREPROJECT Volume amounts per Sphere project:\t http://www.sphereproject.org/ \t\tUSA CARGO CONTROL E-Track system \t(http://www.usacargocontrol.com) Workplace Hazardous Material Identification System (WHMIS classification system) http://www.hc-sc.gc.ca/ewh-semt/pubs/occup-travail/ref_man/ref_manual_index-eng.php						
SYS.1.2.4	Order of Precedence	In the event of a conflict between the text of this document and references cited herein, this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations.	C		Requirement SYS.1.2 HASS System Applicable Documents			
SYS.1.3	REQUIREMENTS		nil		Requirement SYS.1 HASS System	Requirement SYS.1.3.1 General Requirement SYS.1.3.2 Environmental Operating Conditions Requirement SYS.1.3.3 Performance Requirements Requirement SYS.1.3.4 Design		
SYS.1.3.1	General	This section defines the performance, design, and environmental requirements for the HASS.	nil		Requirement SYS.1.3 REQUIREMENTS			
SYS.1.3.2	Environmental Operating Conditions	The HASS shall be capable of operations in climatic conditions including rain, snow, salt fog, ice, dust, sand, high humidity, high wind, hot and cold temperature extremes. Capabilities of the shelter solution shall not be degraded when exposed to climatic conditions.	nil		Requirement SYS.1.3 REQUIREMENTS	Requirement SYS.1.3.2.1 Temperature Requirement SYS.1.3.2.2 Rain Requirement SYS.1.3.2.3 Sand Conditions Requirement SYS.1.3.2.4 Dust Conditions Requirement SYS.1.3.2.5 Icing Conditions Requirement SYS.1.3.2.6 Humidity Requirement SYS.1.3.2.7.A Operation with Fungus Requirement SYS.1.3.2.7.B Degradation by Fungus Requirement SYS.1.3.2.8.A Operation & Degradation by Mold Requirement SYS.1.3.2.8.B COTS Mold Resistance	Issue Issue.24 -> SYS-FUNC - Missing Requirement (s) for Shelter Insulation/Temperature Regulation	Function A.1.2 Operate Function A.1.2.1 Protect

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Requirement SYS.1.3.2.9.A Operation & Degradation by Mildew Requirement SYS.1.3.2.9.B COTS Mildew Resistance Requirement SYS.1.3.2.10 Wind Requirement SYS.1.3.2.11 Snow Requirement SYS.1.3.2.12 Salt Fog		
SYS.1.3.2.1	Temperature	The HASS shall operate at normal capacity without degradation in ambient temperatures ranging from –22o F to 131o F (Threshold) and 144 o F (Objective) (–30o C to 55o C [Threshold] and 62.2o C [Objective]).	C		Requirement MNS.1.1.1.1.J Cold Temperature Extreme Operations Requirement MNS.1.1.1.1.K Hot Temperature Extreme Operations Requirement MNS.1.1.1.2.J Degradation in Hot Temperature Extremes Requirement MNS.1.1.1.2.K Degradation in Cold Temperature Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.2	Rain	The HASS shall operate without degradation in non-accumulating rain conditions with rainfall rates up to 2.5 inches per hour (Threshold) and 4 inches per hour (Objective).	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.3	Sand Conditions	The HASS shall operate without degradation in blowing sand conditions with sand concentrations up to 1.1 ± 0.3 grams per cubic meter (0.033 ± 0.0075 grams per cubic foot), concurrent with particle size between 150 to 850 micrometers, and concurrent with wind speeds up to 40 miles per hour in accordance with MIL-STD-810G.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.1.G Sand Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement MNS.1.1.1.2.G Degradation in Sand Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.4	Dust Conditions	The HASS shall be capable of operation without degradation in blowing dust conditions with particle size less than or equal to 149 micrometers concurrent with wind speeds up to 20 miles per hour in accordance with MIL-STD-810G.	C		Requirement MNS.1.1.1.1.F Dust Extreme Operations Requirement MNS.1.1.1.2.F Degradation in Dust Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.5	Icing Conditions	The HASS shall operate without degradation in freezing rain/ice conditions with ice	C		Requirement MNS.1.1.1.1.E Ice Extreme Operations Requirement			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		accumulations of .5 inches (Threshold) and 3 inches (Objective).			MNS.1.1.1.2.E Degradation in Ice Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.6	Humidity	The HASS shall operate without degradation in high humidity conditions of up to 100% Relative Humidity (RH) in accordance with MIL-STD-810G.	C		Requirement MNS.1.1.1.1.H High Humidity Extreme Operations Requirement MNS.1.1.1.2.H Degradation in High Humidity Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.7.A	Operation with Fungus	The HASS shall operate without degradation after exposure to fungus.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.7.B	Degradation by Fungus	The HASS shall experience only a Light (Threshold) and trace (Objective) amount of Fungus growth on the shelter as defined in MIL-STD-810G through its operational lifecycle.	C		Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.8.A	Operation & Degradation by Mold	The HASS shall operate without degradation through its operational lifecycle after exposure to mold.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.8.B	COTS Mold Resistance	The HASS shall be mold resistant consistent with best commercial practices.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement MNS.1.3.5 Shelter Components Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.9.A	Operation & Degradation by Mildew	The HASS shall operate without degradation through its operational lifecycle after exposure to mildew.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.9.B	COTS Mildew Resistance	The HASS shall be mildew resistant consistent with best commercial practices.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.2.A Degradation in			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Rain Extremes Requirement MNS.1.3.5 Shelter Components Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.10	Wind	The HASS shall be capable of operation without degradation in high wind conditions with wind speeds up to 40 miles per hour (Threshold) and 100 miles per hour (Objective).	C		Requirement MNS.1.1.1.1.I High Wind Extreme Operations Requirement MNS.1.1.1.2.I Degradation in High Wind Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.11	Snow	The HASS shall be capable of sustaining snow loads up to .0435 psi (Threshold) and .058 psi (Objective) without damage.	C		Requirement MNS.1.1.1.1.B Snow Extreme Operations Requirement MNS.1.1.1.2.B Degradation in Snow Extremes Requirement SYS.1.3.2 Environmental Operating Conditions			
SYS.1.3.2.12	Salt Fog	The HASS shall operate in salt fog conditions without degradation (see degradation definition below) in accordance with MIL-STD-810G. Salt fog degradation is defined as reducing the yield strength of the material by no more than 10% of any structural component (Threshold) and 5% (Objective).	C		Requirement MNS.1.1.1.1.C Salt Spray Extreme Operations Requirement MNS.1.1.1.1.D Fog Extreme Operations Requirement MNS.1.1.1.2.C Degradation in Salt Spray Extremes Requirement MNS.1.1.1.2.D Degradation in Fog Extremes Requirement SYS.1.3.2 Environmental Operating Conditions		Issue Issue.12 -> MNS Salt Spray trace to SYS Salt Fog	
SYS.1.3.3	Performance Requirements		nil		Requirement SYS.1.3 REQUIREMENTS	Requirement SYS.1.3.3.1 HASS Operational Lifecycle Requirement SYS.1.3.3.2 HASS Operating Terrain Requirement SYS.1.3.3.3 HASS Water-Resistance Requirement SYS.1.3.3.4.A HASS Reliability Requirement SYS.1.3.3.4.B.1 Preventive Maintainability Requirement SYS.1.3.3.4.B.2 Corrective Maintainability Requirement SYS.1.3.3.5 Operation After Vibration Exposure Requirement SYS.1.3.3.6 Altitude	Issue Issue.17 -> SYS - Missing Requirements in System Spec for Assembly Issue Issue.22 -> SYS-Missing Sys Spec Reliability Requirements at 1.3.3.4.x	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Requirement SYS.1.3.3.7 HASS Long Term Storage Needs Requirement SYS.1.3.3.8 HASS Assembly Requirement SYS.1.3.3.8.A HASS Assembly General Purpose Tools Requirement SYS.1.3.3.8.B HASS Assembly Special Tools Requirement SYS.1.3.3.8.C HASS COTS Assembly Tools Requirement SYS.1.3.3.8.D HASS Assembly Tools Training Requirement SYS.1.3.3.8.E HASS Assembly Skills Requirement SYS.1.3.3.9 HASS Operation Skills		
SYS.1.3.3.1	HASS Operational Lifecycle	The HASS system shall survive an operational usage duration of 2.5 years (Threshold) and 5 years (Objective) once deployed.	P		Requirement MNS.1.1.2.2 Operational Usage Duration Requirement SYS.1.3.3 Performance Requirements			
SYS.1.3.3.2	HASS Operating Terrain	The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces. The HASS shall be capable of being leveled and stabilized (Objective). The system shall be able to operate on a surface with a 12” slope over the 20’ length (Threshold).	nil		Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.2.1 HASS Operating Terrain Variance Requirement SYS.1.3.3.2.2.A Leveling HASS on Operating Terrain Requirement SYS.1.3.3.2.2.B Stabilizing HASS on Operating Terrain Requirement SYS.1.3.3.2.3 HASS Operating Slope		
SYS.1.3.3.2.1	HASS Operating Terrain Variance	The HASS shall be capable of operations on various terrain. Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces.	C		Requirement MNS.1.2.1.1 Terrain Adaptability Requirement SYS.1.3.3.2 HASS Operating Terrain			
SYS.1.3.3.2.2.A	Leveling HASS on Operating Terrain	The HASS shall be capable of being leveled (Objective).	C		Requirement MNS.1.2.1.2.A HASS Shelter Leveling Requirement SYS.1.3.3.2 HASS Operating Terrain			
SYS.1.3.3.2.2.B	Stabilizing HASS on Operating Terrain	The HASS shall be capable of being stabilized (Objective).	C		Requirement MNS.1.2.1.2.B HASS Shelter Stabilizing Requirement SYS.1.3.3.2 HASS Operating Terrain			
SYS.1.	HASS	The system shall be able to operate on a	P		Requirement MNS.1.2.1.3 HASS			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
3.3.2.3	Operating Slope	surface with a 12” slope over the 20’ length (Threshold).			Operation of Uneven Terrain Requirement SYS.1.3.3.2 HASS Operating Terrain			
SYS.1.3.3.3	HASS Water-Resistance	The HASS, without additional equipment or preparation, shall be water-resistant to preclude internal damage from the applicable environmental operating requirements contained in Section 1.3.2 of this specification.	C		Requirement MNS.1.1.1.1.A Rain Extreme Operations Requirement MNS.1.1.1.1.B Snow Extreme Operations Requirement MNS.1.1.1.1.C Salt Spray Extreme Operations Requirement MNS.1.1.1.1.D Fog Extreme Operations Requirement MNS.1.1.1.1.E Ice Extreme Operations Requirement MNS.1.1.1.1.H High Humidity Extreme Operations Requirement MNS.1.1.1.2.A Degradation in Rain Extremes Requirement MNS.1.1.1.2.B Degradation in Snow Extremes Requirement MNS.1.1.1.2.C Degradation in Salt Spray Extremes Requirement MNS.1.1.1.2.D Degradation in Fog Extremes Requirement MNS.1.1.1.2.E Degradation in Ice Extremes Requirement MNS.1.1.1.2.H Degradation in High Humidity Extremes Requirement SYS.1.3.3 Performance Requirements			
SYS.1.3.3.4.1	HASS Reliability Constraint	The HASS shall demonstrate a 95% (T) and 99% (O) reliability over the intended lifecycle (2.5 years) with a lower bound 90% confidence interval.	C		Requirement MNS.1.1.6 Reliability Requirement SYS.1.3.3.4.A HASS Reliability		Issue Issue.23 -> SUBSYS -->> MNS-to-SYS Allocation of Reliability Requirement ... addressing Essential Functional Failures	
SYS.1.3.3.4.2	Preventive Maintenance in	Any preventive maintenance actions performed on the HASS in storage shall be performed by trained personnel requiring	C		Requirement MNS.1.1.5 Maintainability Requirement MNS.1.2.7.1.D Minimize Hazards			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Storage	only COTS tools. Preventive maintenance actions in storage are defined as detailed inspections/system checkout and scheduled safety inspections.			to Maintainers During Storage Requirement SYS.1.3.3.4.B.1 Preventive Maintainability			
SYS.1.3.3.4.3	Preventive Maintenance in Operations	Any preventive maintenance actions performed on the HASS in operations shall be performed by an untrained adult with basic tools from the supplied general purpose tool kit. Preventive maintenance actions in operations are defined as visual inspections and external adjustments.	C		Requirement MNS.1.1.5 Maintainability Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.3.4.B.1 Preventive Maintainability			
SYS.1.3.3.4.4.1	Corrective Maintenance Tools	All corrective maintenance shall be performed utilizing supplied general purpose tools.	C		Requirement MNS.1.1.5 Maintainability Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.4.2	Corrective Maintenance Specialized Tools	HASS shall be designed to require no specialized tools for repairs.	C		Requirement MNS.1.1.5.1.1 Specialized Repair Tools Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.4.3	Corrective Maintenance COTS Tools	HASS shall be designed to require no specialized tools for repairs.	C		Requirement MNS.1.1.5.1.2 COTS Repair Tools Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.4.4	Corrective Maintenance Skills	Tools necessary to perform the required repair tasks shall require no specialized training.	C		Requirement MNS.1.1.5.1.3 HASS Repair Skills Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.4.5	Corrective Maintenance Training	Any repairs shall be performed by an untrained adult.	C		Requirement MNS.1.1.5.1.4 HASS Repair Training Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.4.6	Corrective Maintenance Materials Inclusive	Materials necessary for repair shall be included in the HASS.	C		Requirement MNS.1.1.5.1.5 HASS Repair Materials Inclusive Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
SYS.1.3.3.4.5	Mean Time Between Maintenance	The HASS shall have a mean time between maintenance (MTBM) of no less than 615 hours.	C		Requirement MNS.1.1.5 Maintainability Requirement SYS.1.3.3.4.B.1 Preventive Maintainability Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.6	Mean Active Maintenance Time	The HASS shall have a mean active maintenance time (Mbar) of no more than 35 minutes.	C		Requirement MNS.1.1.5 Maintainability Requirement SYS.1.3.3.4.B.1 Preventive Maintainability Requirement SYS.1.3.3.4.B.2 Corrective Maintainability			
SYS.1.3.3.4.A	HASS Reliability	The HASS System shall be reliable so as to not require a supply chain.	C		Requirement MNS.1.1.6 Reliability Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.4.1 HASS Reliability Constraint		
SYS.1.3.3.4.B.1	Preventive Maintainability	The HASS System shall require minimal preventive maintenance throughout its lifecycle	C		Requirement MNS.1.1.5 Maintainability Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.4.2 Preventive Maintenance in Storage Requirement SYS.1.3.3.4.3 Preventive Maintenance in Operations Requirement SYS.1.3.3.4.5 Mean Time Between Maintenance Requirement SYS.1.3.3.4.6 Mean Active Maintenance Time		
SYS.1.3.3.4.B.2	Corrective Maintainability	The HASS System shall require minimal corrective maintenance system throughout its lifecycle	C		Requirement MNS.1.1.5 Maintainability Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.4.4.1 Corrective Maintenance Tools Requirement SYS.1.3.3.4.4.2 Corrective Maintenance Specialized Tools Requirement SYS.1.3.3.4.4.3 Corrective Maintenance COTS Tools Requirement SYS.1.3.3.4.4.4 Corrective Maintenance Skills Requirement SYS.1.3.3.4.4.5 Corrective Maintenance Training Requirement SYS.1.3.3.4.4.6 Corrective Maintenance Materials Inclusive Requirement SYS.1.3.3.4.5 Mean Time Between Maintenance Requirement SYS.1.3.3.4.6 Mean Active Maintenance Time		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
SYS.1.3.3.5	Operation After Vibration Exposure	The HASS shall operate at normal capacity without degradation after exposure to the following vibration profile in accordance with MIL-STD-810 G section 514.6. RMS Acceleration:1 (Grms): Vertical - 1.04; Transverse - 0.20; Longitudinal - 0.74. Velocity (in/sec) (peak single amplitude):1 Vertical – 7.61; Transverse – 1.21; Longitudinal – 4.59. Displacement (in) (peak double amplitude):1 Vertical – 0.20 Transverse – 0.02; Longitudinal – 0.11.	P	Vibration profie is in accordance with MIL-STD-810 G section 514.6.	Requirement MNS.1.1.1 Operational Environment Requirement SYS.1.3.3 Performance Requirements		Issue Issue.14 -> SYS - Orphan Vibration requirements in system spec	
SYS.1.3.3.6	Altitude	The HASS shall be capable of transport without degradation at altitudes from 0 to 35,000 feet above sea level. The system shall be operable from 0 to 10,000 feet above sea level. Procedures for high altitude operation (if different than sea level operation) shall be provided.	nil		Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.6.1 High Altitude Transport Requirement SYS.1.3.3.6.2 High Altitude Operation Requirement SYS.1.3.3.6.3 High Altitude Operation Procedures		
SYS.1.3.3.6.1	High Altitude Transport	The HASS shall be capable of transport without degradation at altitudes from 0 to 35,000 feet above sea level.	P		Requirement MNS.1.1.3.A Air Transportability Requirement SYS.1.3.3.6 Altitude			
SYS.1.3.3.6.2	High Altitude Operation	The system shall be operable from 0 to 10,000 feet above sea level.	C	Derived based on logical deduction after meeting with staakeholders.	Requirement MNS.1.1.1 Operational Environment Requirement SYS.1.3.3.6 Altitude		Issue Issue.15 -> SYS - Orphan High Altitude Operation Rqmt in System Spec	
SYS.1.3.3.6.3	High Altitude Operation Procedures	Procedures for high altitude operation (if different than sea level operation) shall be provided.	F		Requirement MNS.1.1.1 Operational Environment Requirement MNS.1.1.2 Operational Lifecycle Requirement MNS.1.2.2 Food Preparation, Storage and Distribution Requirement MNS.1.2.5 Water Purification, Storage and Distribution Requirement SYS.1.3.3.6 Altitude		Issue Issue.16 -> SYS - Missing Requirements for Skills/Training for HASS Operation, r.e. High Altitude documentation	
SYS.1.	HASS	The HASS shall be capable of storage for up	nil		Requirement SYS.1.3.3	Requirement SYS.1.3.3.7.1		Function

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
3.3.7	Long Term Storage Needs	to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Applicable packaging of the HASS shall be provisioned for 10 years of storage. Functional capacity is defined as the HASS' ability to operate in conformance with environmental conditions specified in section 3.2.			Performance Requirements	HASS Long Term Storage Duration Requirement SYS.1.3.3.7.2 HASS Long Term Storage Provisioning		A.1.1 Deploy Function A.1.1.1 Survive Storage
SYS.1.3.3.7.1	HASS Long Term Storage Duration	The HASS shall be capable of storage for up to 5 years (Threshold), 10 years (Objective) without reduction in functional capacity. Functional capacity is defined as the HASS' ability to operate in conformance with environmental conditions specified in section 3.2.	C		Requirement MNS.1.1.2.1 Shelf Life Requirement MNS.1.2.10.1 Long Term Storage Duration Requirement SYS.1.3.3.7 HASS Long Term Storage Needs			
SYS.1.3.3.7.2	HASS Long Term Storage Provisioning	Applicable packaging of the HASS shall be provisioned for 10 years of storage.	C		Requirement MNS.1.1.2.1 Shelf Life Requirement MNS.1.2.10.2 Long Term Storage Packaging Requirement SYS.1.3.3.7 HASS Long Term Storage Needs			
SYS.1.3.3.8	HASS Assembly		nil		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements	Requirement SYS.1.3.3.8.A HASS Assembly General Purpose Tools Requirement SYS.1.3.3.8.B HASS Assembly Special Tools Requirement SYS.1.3.3.8.C HASS COTS Assembly Tools Requirement SYS.1.3.3.8.D HASS Assembly Tools Training Requirement SYS.1.3.3.8.E HASS Assembly Skills		Function A.1.1 Deploy Function A.1.1.3 Assemble
SYS.1.3.3.8.A	HASS Assembly General Purpose Tools	Assembly of the HASS shall be performed utilizing supplied general purpose tools.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements Requirement SYS.1.3.3.8 HASS Assembly			
SYS.1.3.3.8.B	HASS Assembly Special Tools	The HASS shall require no specialized tools for assembly.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements Requirement SYS.1.3.3.8 HASS Assembly			
SYS.1.3.3.8.C	HASS COTS Assembly	All tools required to assemble the HASS shall be COTS.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Tools				Requirements Requirement SYS.1.3.3.8 HASS Assembly			
SYS.1. 3.3.8.D	HASS Assembly Tools Training	Tools necessary to perform the assembly tasks shall require no specialized training.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements Requirement SYS.1.3.3.8 HASS Assembly			
SYS.1. 3.3.8.E	HASS Assembly Skills	All assembly tasks shall be performed by an untrained adult.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements Requirement SYS.1.3.3.8 HASS Assembly			
SYS.1. 3.3.9	HASS Operation Skills	Operation of the HASS shall require no specialized skills or training.	C		Requirement MNS.1.1.4 Shelter Capability Requirement SYS.1.3.3 Performance Requirements			
SYS.1. 3.4	Design		nil		Requirement SYS.1.3 REQUIREMENTS	Requirement SYS.1.3.4.1 HASS Shelter Capability Requirement SYS.1.3.4.2 HASS Materials Requirement SYS.1.3.4.3 HASS Shelter Color Requirement SYS.1.3.4.4 HASS Labeling Requirement SYS.1.3.4.5 Transport Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.8 HASS Communications Requirement SYS.1.3.4.9.A Natural Lighting Requirement SYS.1.3.4.9.B Natural Lighting Adjustment Requirement SYS.1.3.4.9.C Securing HASS Natural Lighting Requirement SYS.1.3.4.9.D Secured Natural Lighting Opaque Requirement SYS.1.3.4.10 Artificial Lighting Requirement SYS.1.3.4.11.1 HASS Volume Divider Division Requirement SYS.1.3.4.11.A HASS Occupant Privacy		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Requirement SYS.1.3.4.11.B HASS Volume Divider Opaque Requirement SYS.1.3.4.12 HASS Ventilation Provisions Requirement SYS.1.3.4.13.A HASS-to-HASS Shelter Connections Requirement SYS.1.3.4.13.B.1 Component Means to Connect HASS Shelters Requirement SYS.1.3.4.13.B.2 Tool Means to Connect HASS Shelters Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers		
SYS.1.3.4.1	HASS Shelter Capability	The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective). The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant. Covered floor space is defined as floor space which separates the HASS' users from the environmental operating conditions stated in section 3.2.	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.1.1 HASS Shelter Occupancy Requirement SYS.1.3.4.1.2 HASS Occupancy Floor Space	Issue Issue.24 -> SYS-FUNC - Missing Requirement (s) for Shelter Insulation/Temperature Regulation	Function A.1.2 Operate Function A.1.2.2 Use Shelter
SYS.1.3.4.1.1	HASS Shelter Occupancy	The HASS shall provide shelter for 5 occupants (Threshold) and 10 occupants (Objective).	C		Requirement MNS.1.1.4.1 Shelter Occupancy Requirement SYS.1.3.4.1 HASS Shelter Capability			
SYS.1.3.4.1.2	HASS Occupancy Floor Space	The HASS shall have 3.5m^2 (Threshold) and 4.5m^2 (Objective) covered floor space per occupant. Covered floor space is defined as floor space which separates the HASS' users from the environmental operating conditions stated in section 3.2.	C		Requirement MNS.1.1.4.2 Shelter Floor Space per Occupant Requirement SYS.1.3.4.1 HASS Shelter Capability			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
SYS.1.3.4.2	HASS Materials	HASS shall not contain any materials hazardous to the occupant's health and environment; precluding materials classified as Class A, Class C, Class D, Class E, and Class F per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system. The HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture. All rubber products utilized shall be ozone resistant consistent with best commercial practice.	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.2.1 HASS Modification Requirement SYS.1.3.4.2.2 COTS Material and Component Selection Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials Requirement SYS.1.3.4.2.4 Toxicity of Materials Requirement SYS.1.3.4.2.5 Treatment and Painting of Materials Requirement SYS.1.3.4.2.A HASS Hazardous Materials Requirement SYS.1.3.4.2.B HASS Ozone Depleting Substances Requirement SYS.1.3.4.2.C HASS Ozone Resistant Materials		
SYS.1.3.4.2.1	HASS Modification	The HASS shall be capable of being modified leveraging recycled, recovered, locally available, or environmentally preferable materials.	nil		Requirement SYS.1.3.4.2 HASS Materials	Requirement SYS.1.3.4.2.1.A HASS Modification with Recycled Materials Requirement SYS.1.3.4.2.1.B HASS Modification with Recovered Materials Requirement SYS.1.3.4.2.1.C HASS Modification with Locally Available Materials Requirement SYS.1.3.4.2.1.D HASS Modification with Environmentally Preferable Materials		
SYS.1.3.4.2.1.A	HASS Modification with Recycled Materials	The HASS shall be capable of being modified leveraging recycled materials.	C		Requirement MNS.1.2.9.4.A Use of Recycled Materials Requirement SYS.1.3.4.2.1 HASS Modification			
SYS.1.3.4.2.1.B	HASS Modification with Recovered Materials	The HASS shall be capable of being modified leveraging recovered materials.	C		Requirement MNS.1.2.9.4.B Use of Recovered Materials Requirement SYS.1.3.4.2.1 HASS Modification			
SYS.1.3.4.2.1.	HASS Modificatio	The HASS shall be capable of being modified leveraging locally available	C		Requirement MNS.1.2.9.4.A Use of Recycled Materials		Issue Issue.19 ->	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
C	n with Locally Available Materials	materials.			Requirement MNS.1.2.9.4.B Use of Recovered Materials Requirement MNS.1.2.9.4.C Use of Environmentally Preferable Materials Requirement SYS.1.3.4.2.1 HASS Modification		SYS - HASS Modification with Locally Available Materials - Redundant and Does not Trace from MNS	
SYS.1.3.4.2.1.D	HASS Modification with Environmentally Preferable Materials	The HASS shall be capable of being modified leveraging nvironmentally preferable materials.	C		Requirement MNS.1.2.9.4.C Use of Environmentally Preferable Materials Requirement SYS.1.3.4.2.1 HASS Modification			
SYS.1.3.4.2.2	COTS Material and Component Selection	The HASS shall be comprised of 90% (T) and 100% (O) COTS components. COTS components are defined as readily available components or assemblies which require no modifications or development to integrate.	C		Requirement MNS.1.3.5 Shelter Components Requirement SYS.1.3.4.2 HASS Materials			
SYS.1.3.4.2.3	Flammable Liquids and Materials	The HASS shall not include flammable liquids and materials in a deliverable end item in accordance with OSHA 1926.152 Class 1A, 1B and 1C.	nil		Requirement SYS.1.3.4.2 HASS Materials	Requirement SYS.1.3.4.2.3.A.1 Flammable Liquids Use per OSHA 1926.152 Class 1A Requirement SYS.1.3.4.2.3.A.2 Flammable Liquids Use per OSHA 1926.152 Class 1B Requirement SYS.1.3.4.2.3.A.3 Flammable Liquids Use per OSHA 1926.152 Class 1C Requirement SYS.1.3.4.2.3.B.1 Flammable Materials Use per OSHA 1926.152 Class 1A Requirement SYS.1.3.4.2.3.B.2 Flammable Materials Use per OSHA 1926.152 Class 1B Requirement SYS.1.3.4.2.3.B.3 Flammable Materials Use per OSHA 1926.152 Class 1C		
SYS.1.3.4.2.3.A.1	Flammable Liquids Use per OSHA 1926.152	The HASS shall not include flammable liquids in a deliverable end item in accordance with OSHA 1926.152 Class 1A.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials		Issue Issue.20 -> Sys Spec requirement on Use of	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Class 1A						Flamable Liquids does not trace from MNS	
SYS.1.3.4.2.3.A.2	Flammable Liquids Use per OSHA 1926.152 Class 1B	The HASS shall not include flammable liquids in a deliverable end item in accordance with OSHA 1926.152 Class 1B.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials		Issue Issue.20 -> Sys Spec requirement on Use of Flamable Liquids does not trace from MNS	
SYS.1.3.4.2.3.A.3	Flammable Liquids Use per OSHA 1926.152 Class 1C	The HASS shall not include flammable liquids in a deliverable end item in accordance with OSHA 1926.152 Class 1C.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials		Issue Issue.20 -> Sys Spec requirement on Use of Flamable Liquids does not trace from MNS	
SYS.1.3.4.2.3.B.1	Flammable Materials Use per OSHA 1926.152 Class 1A	The HASS shall not include flammable materials in a deliverable end item in accordance with OSHA 1926.152 Class 1A.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials			
SYS.1.3.4.2.3.B.2	Flammable Materials Use per OSHA 1926.152 Class 1B	The HASS shall not include flammable materials in a deliverable end item in accordance with OSHA 1926.152 Class 1B.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials			
SYS.1.3.4.2.3.B.3	Flammable Materials Use per OSHA 1926.152 Class 1C	The HASS shall not include flammable materials in a deliverable end item in accordance with OSHA 1926.152 Class 1C.	C		Requirement MNS.1.2.9.5 Use of Flamable Materials Requirement SYS.1.3.4.2.3 Flammable Liquids and Materials			
SYS.1.3.4.2.4	Toxicity of Materials	The HASS shall not cause skin irritations or other injuries, and shall not produce vapor hazards, including the emission of toxic or noxious odors to users under all	nil		Requirement SYS.1.3.4.2 HASS Materials	Requirement SYS.1.3.4.2.4.A Toxicity of Materials to Skin Requirement SYS.1.3.4.2.4.B Toxicity of Materials Causing		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		environmental conditions.				Injuries Requirement SYS.1.3.4.2.4.C Toxicity of Materials Causing Vapor Hazards		
SYS.1.3.4.2.4.A	Toxicity of Materials to Skin	The HASS shall not cause skin irritations.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.4 Toxicity of Materials			
SYS.1.3.4.2.4.B	Toxicity of Materials Causing Injuries	The HASS shall not cause other injuries.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.4 Toxicity of Materials		Issue Issue.21 -> SYS - Insufficient Requirement - Toxicity of Materials causing Injuries	
SYS.1.3.4.2.4.C	Toxicity of Materials Causing Vapor Hazards	The HASS shall not produce vapor hazards, including the emission of toxic or noxious odors to users under all environmental conditions.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.4 Toxicity of Materials			
SYS.1.3.4.2.5	Treatment and Painting of Materials	Any combustible materials shall be treated as to minimize their combustibility so that char length does not exceed 7 inches. Combustibility is defined as any material having a rating of Class II, or III IAW OSHA 1926.152 flammability and combustibility classification system.	P		Requirement MNS.1.2.9.6 Use of Combustible Materials Requirement SYS.1.3.4.2 HASS Materials			
SYS.1.3.4.2.A	HASS Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health and environment; precluding materials classified	nil		Requirement SYS.1.3.4.2 HASS Materials	Requirement SYS.1.3.4.2.A.1 HASS Class A Health Hazardous Materials		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		as Class A, Class C, Class D, Class E, and Class F per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.				Requirement SYS.1.3.4.2.A.2 HASS Class C Health Hazardous Materials Requirement SYS.1.3.4.2.A.3 HASS Class D Health Hazardous Materials Requirement SYS.1.3.4.2.A.4 HASS Class E Health Hazardous Materials Requirement SYS.1.3.4.2.A.5 HASS Class F Health Hazardous Materials Requirement SYS.1.3.4.2.A.6 HASS Class A Environment Hazardous Materials Requirement SYS.1.3.4.2.A.7 HASS Class C Environment Hazardous Materials Requirement SYS.1.3.4.2.A.8 HASS Class D Environment Hazardous Materials Requirement SYS.1.3.4.2.A.9 HASS Class E Environment Hazardous Materials Requirement SYS.1.3.4.2.A.10 HASS Class F Environment Hazardous Materials		
SYS.1.3.4.2.A.1	HASS Class A Health Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health; precluding materials classified as Class A per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials		Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
SYS.1.3.4.2.A.2	HASS Class C Health Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health; precluding materials classified as Class C per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards		Issue Issue.18 -> MNS Hazardous Materials Rqmts do not	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Requirement SYS.1.3.4.2.A HASS Hazardous Materials		appear to trace to SYS SPEC Hazardous Materials Requirements	
SYS.1.3.4.2.A.3	HASS Class D Health Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health; precluding materials classified as Class D per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials		Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
SYS.1.3.4.2.A.4	HASS Class E Health Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health; precluding materials classified as Class E per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials		Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials Requirements	
SYS.1.3.4.2.A.5	HASS Class F Health Hazardous Materials	HASS shall not contain any materials hazardous to the occupant's health; precluding materials classified as Class F per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials		Issue Issue.18 -> MNS Hazardous Materials Rqmts do not appear to trace to SYS SPEC Hazardous Materials	

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
							Requirements	
SYS.1.3.4.2.A.6	HASS Class A Environment Hazardous Materials	HASS shall not contain any materials hazardous to the environment; precluding materials classified as Class A per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials			
SYS.1.3.4.2.A.7	HASS Class C Environment Hazardous Materials	HASS shall not contain any materials hazardous to the environment; precluding materials classified as Class C per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials			
SYS.1.3.4.2.A.8	HASS Class D Environment Hazardous Materials	HASS shall not contain any materials hazardous to the environment; precluding materials classified as Class D per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials			
SYS.1.3.4.2.A.9	HASS Class E Environment Hazardous Materials	HASS shall not contain any materials hazardous to the environment; precluding materials classified as Class E per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials			
SYS.1.3.4.2.A.10	HASS Class F Environment Hazardous Materials	HASS shall not contain any materials hazardous to the environment; precluding materials classified as Class F per Canada's Workplace Hazardous Material Identification System (WHMIS) classification system.	C		Requirement MNS.1.2.9.1.B Materials Hazardous to Environment per NEPA Requirement MNS.1.2.9.1.D Materials Hazardous to Environment per International			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Standards Requirement SYS.1.3.4.2.A HASS Hazardous Materials			
SYS.1.3.4.2.B	HASS Ozone Depleting Substances	The HASS shall be free of ozone depleting substances per applicable Federal regulations in effect on the date of manufacture.	C		Requirement MNS.1.2.9.2 Ozone Depletion Prevention Requirement SYS.1.3.4.2 HASS Materials			
SYS.1.3.4.2.C	HASS Ozone Resistant Materials	All rubber products utilized shall be ozone resistant consistent with best commercial practice.	C		Requirement MNS.1.2.9.3 Ozone Resistant Rubber Requirement SYS.1.3.4.2 HASS Materials			
SYS.1.3.4.3	HASS Shelter Color	The HASS shall be colored white, Number FS 37925, in accordance FED-STD-595(1994). Exceptions may be made where cultural and political sensitivities are taken into account. For example, in the use of colors used in national or factional flags in accordance with Transitional Shelter Standards Version 10B (2010).	C		Requirement MNS.1.3.4.1.A Use of Military Colors Requirement MNS.1.3.4.1.B Use of Camouflage Colors Requirement MNS.1.3.4.2.A Cultural Sensitivities in HASS Color Requirement MNS.1.3.4.2.B Political Sensitivities in HASS Color Requirement SYS.1.3.4 Design			
SYS.1.3.4.4	HASS Labeling	The HASS shall be marked in accordance with Transitional Shelter Standards Version 10B (2010). Any marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive in accordance with MIL-STD-130M, Section 4.1-4.3. Ordinary usage, handling, storage, and the like, of a product are considered in the determination of the permanency of a marking.	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.4.A HASS Labeling Identification Requirement SYS.1.3.4.4.B HASS Labeling Method		
SYS.1.3.4.4.A	HASS Labeling Identification	The HASS shall be marked in accordance with Transitional Shelter Standards Version 10B (2010).	C		Requirement MNS.1.3.3 Marking Requirement SYS.1.3.4.4 HASS Labeling			
SYS.1.3.4.4.B	HASS Labeling Method	Any marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive in accordance with MIL-STD-130M, Section 4.1-4.3. Ordinary	C		Requirement MNS.1.3.3 Marking Requirement SYS.1.3.4.4 HASS Labeling			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		usage, handling, storage, and the like, of a product are considered in the determination of the permanency of a marking.						
SYS.1.3.4.5	Transport	In transport configuration, the HASS' pack-out configuration width shall be small enough to fit through a standard 8'x8'x20' ISO container. In transport mode, the HASS shall tie down in a standard 8'x 8'x 20' ISO container utilizing an E-Track system (http://www.usacargocontrol.com) with ratchet straps without causing any damage to the HASS or its components. In transport mode, the HASS shall be capable of surviving the vibration requirements in section 3.3.5 without any damage or degradation of performance.	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.5.1 Transportation Configuration Requirement SYS.1.3.4.5.A HASS Container Transport Requirement SYS.1.3.4.5.B HASS Tie-Down for Transport Requirement SYS.1.3.4.5.C HASS Transport Vibration		Function A.1.1 Deploy Function A.1.1.2 Transport
SYS.1.3.4.5.1	Transportation Configuration	Transportation configuration is defined in Figure 1.1. In its transportation configuration, 4 HASSs shall fit on 1 standard pallet (Objective) and 1 HASS on 3 standard pallets (Threshold). Standard pallet size is defined as 48" x 45" with standard forklift pocket dimensions IAW ISO Standard 1496-1 (1990).	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5 Transport	Requirement SYS.1.3.4.5.1.1 Forklift for Transport		
SYS.1.3.4.5.1.1	Forklift for Transport	The HASS, in transportation configuration, shall be capable of being lifted into and out of standard shipping containers by a forklift without damage.	nil		Requirement SYS.1.3.4.5.1 Transportation Configuration	Requirement SYS.1.3.4.5.1.1.A Forklift into Standard Shipping Containers Requirement SYS.1.3.4.5.1.1.B Forklift out of Standard Shipping Containers		
SYS.1.3.4.5.1.1.A	Forklift into Standard Shipping Containers	The HASS, in transportation configuration, shall be capable of being lifted into standard shipping containers by a forklift without damage.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5.1.1 Forklift for Transport			
SYS.1.3.4.5.1.1.B	Forklift out of Standard Shipping Containers	The HASS, in transportation configuration, shall be capable of being lifted out of standard shipping containers by a forklift without damage.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Transportability Requirement SYS.1.3.4.5.1.1 Forklift for Transport			
SYS.1.3.4.5.A	HASS Container Transport	In transport configuration, the HASS' pack-out configuration width shall be small enough to fit through a standard 8'x8'x20' ISO container.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5 Transport			
SYS.1.3.4.5.B	HASS Tie-Down for Transport	In transport mode, the HASS shall tie down in a standard 8'x 8'x 20' ISO container utilizing an E-Track system (http://www.usacargocontrol.com) with ratchet straps without causing any damage to the HASS or its components.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5 Transport			
SYS.1.3.4.5.C	HASS Transport Vibration	In transport mode, the HASS shall be capable of surviving the vibration requirements in section 1.3.3.5 without any damage or degradation of performance.	nil		Requirement SYS.1.3.4.5 Transport	Requirement SYS.1.3.4.5.C.1 HASS Transport Vibration Damage Requirement SYS.1.3.4.5.C.2 HASS Transport Vibration Degradation		
SYS.1.3.4.5.C.1	HASS Transport Vibration Damage	In transport mode, the HASS shall be capable of surviving the vibration requirements in section 1.3.3.5 without any damage.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5.C HASS Transport Vibration		Issue Issue.14 -> SYS - Orphan Vibration requirements in system spec	
SYS.1.3.4.5.C.2	HASS Transport Vibration Degradation	In transport mode, the HASS shall be capable of surviving the vibration requirements in section 3.3.5 without any degradation of performance.	C		Requirement MNS.1.1.3.A Air Transportability Requirement MNS.1.1.3.B Rail Transportability Requirement MNS.1.1.3.C Ship Transportability Requirement MNS.1.1.3.D Ground Transportability Requirement SYS.1.3.4.5.C HASS Transport Vibration		Issue Issue.14 -> SYS - Orphan Vibration requirements in system spec	
SYS.1.3.4.6	HASS Food	The HASS shall equip occupant(s) with resources for food preparation (Objective),	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.6.1.A Air-Tight Food Storage		Function A.1.2

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Preparation, Storage and Distribution	distribution (Objective) and storage (Threshold). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption in a sanitary manner. Food storage is defined as storing hot, cold, cooked, solid, or liquid food for consumption by the user.				Containers Requirement SYS.1.3.4.6.1.B Water-Proof Food Storage Containers Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions Requirement SYS.1.3.4.6.A Food Preparation Equipping Requirement SYS.1.3.4.6.B Food Storage Equipping Requirement SYS.1.3.4.6.C Food Distribution Equipping		Operate Function A.1.2.3 Serve
SYS.1.3.4.6.1.1	Food Storage Container Volume	Food storage containers shall have a volume of 6 qt. (ea).	C	Volume derived from consultation with food service professional-Master Chief-Navy-25 Years experience as a cook.	Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.4.6.1.A Air-Tight Food Storage Containers Requirement SYS.1.3.4.6.1.B Water-Proof Food Storage Containers			
SYS.1.3.4.6.1.2	Food Storage Container Quantity	Four storage containers of identified volume shall be provided. .	C	Quantity derived from consultation with food service professional - Master Chief-Navy-25 Years experienc	Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.4.6.1.A Air-Tight Food Storage Containers Requirement SYS.1.3.4.6.1.B Water-Proof Food Storage Containers			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
				e as a cook				
SYS.1.3.4.6.1.A	Air-Tight Food Storage Containers	Food storage containers shall be air-tight; as to maximize the ability to preserve the stored food while keeping it uncontaminated.	C		Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution Requirement SYS.1.3.4.6.B Food Storage Equipping	Requirement SYS.1.3.4.6.1.1 Food Storage Container Volume Requirement SYS.1.3.4.6.1.2 Food Storage Container Quantity		
SYS.1.3.4.6.1.B	Water-Proof Food Storage Containers	Food storage containers shall be water proof; as to maximize the ability to preserve the stored food while keeping it uncontaminated.	C		Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution Requirement SYS.1.3.4.6.B Food Storage Equipping	Requirement SYS.1.3.4.6.1.1 Food Storage Container Volume Requirement SYS.1.3.4.6.1.2 Food Storage Container Quantity		
SYS.1.3.4.6.2	Food Preparation & Distribution Kits	Food preparation & distribution kits shall meet Oxfam Transitional Settlement Displaced Populations specifications dated 2005 in relations to kit contents (Objectives) as shown in Table 1, Food Preparation and Distribution Kit Contents.	C		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement MNS.1.2.2.2 HASS Food Distribution Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution Requirement SYS.1.3.4.6.A Food Preparation Equipping Requirement SYS.1.3.4.6.C Food Distribution Equipping	Requirement SYS.1.3.4.6.2.1 Food Preparation & Distribution Kit Material		
SYS.1.3.4.6.2.1	Food Preparation & Distribution Kit Material	All food preparation & distribution kit contents shall be constructed of stainless steel, in accordance with Oxfam Transitional Settlement Displaced Populations specifications dated 2005 (Objective).	C		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement MNS.1.2.2.2 HASS Food Distribution Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits			
SYS.1.3.4.6.3	HASS Food Preparation Provisions	The HASS shall have provisions for food preparation. (Objective). Food preparation is defined as the capability to boil, braise, pan fry and griddle.	C		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution Requirement SYS.1.3.4.6.A Food Preparation Equipping	Requirement SYS.1.3.4.6.3.1 Food Preparation Equipment Heat Transfer Performance Requirement SYS.1.3.4.6.3.2.A Food Preparation Equipment Surface Area Performance Requirement SYS.1.3.4.6.3.2.B.1 Food Preparation Equipment Cooking Time Requirement SYS.1.3.4.6.3.2.B.2 Food		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Preparation Equipment Cooking Recovery Time Requirement SYS.1.3.4.6.3.3 Food Preparation Equipment Cooking Surface Material Requirement SYS.1.3.4.6.3.4 Food Preparation Equipment Efficiency		
SYS.1.3.4.6.3.1	Food Preparation Equipment Heat Transfer Performance	Food preparation equipment shall be capable of bringing 2.5 gallons of water (which is either in direct contact with the equipment or in a separate cooking vessel) to a boil (212F) from 70F in ambient temperatures equal to or greater than 32F in 30 minutes (Objective).	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			
SYS.1.3.4.6.3.2.A	Food Preparation Equipment Surface Area Performance	Food preparation equipment shall be capable of bringing 1.5 sq. ft. of an unloaded cooking surface (for braising, pan frying, and griddling) to a temperature of 375F in ambient temperatures equal to or greater than 32F with a cooking surface temperature equal to the ambient temperature in a maximum of 15 minutes (Objective).	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			
SYS.1.3.4.6.3.2.B.1	Food Preparation Equipment Cooking Time	Food preparation equipment shall be capable of a cook time of 10 minutes per load IAW ASTM F 1275-03(2008) section 10.7 (Cooking energy efficiency and production capacity) (Objective).	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			
SYS.1.3.4.6.3.2.B.2	Food Preparation Equipment Cooking Recovery Time	Food preparation equipment shall be capable of a maximum cooking recovery time of 5 minutes between loads IAW ASTM F 1275-03(2008) section 10.7 (Cooking energy efficiency and production capacity) (Objective).	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			
SYS.1.3.4.6.3.3	Food Preparation Equipment Cooking Surface Material	Food preparation equipment cooking surfaces areas shall be made of corrosion resistant steel (Objective).	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			
SYS.1.3.4.6.3.4	Food Preparation Equipment Efficiency	Food Preparation Equipment Net Efficiency shall be 40% (threshold) and 50% (Objective). Food Preparation Net Efficiency is defined as 2946.5 Btu divided	P		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		by total energy content of fuel used to bring 2.5 gallons of water to a boil.						
SYS.1.3.4.6.A	Food Preparation Equipping	The HASS shall equip occupant(s) with resources for food preparation (Objective).	C		Requirement MNS.1.2.2.1 HASS Food Preparation Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits Requirement SYS.1.3.4.6.3 HASS Food Preparation Provisions		
SYS.1.3.4.6.B	Food Storage Equipping	The HASS shall equip occupant(s) with resources for food storage (Threshold). Food storage is defined as storing hot, cold, cooked, solid, or liquid food for consumption by the user.	C		Requirement MNS.1.2.2.3 HASS Food Storage Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.1.A Air-Tight Food Storage Containers Requirement SYS.1.3.4.6.1.B Water-Proof Food Storage Containers		
SYS.1.3.4.6.C	Food Distribution Equipping	The HASS shall equip occupant(s) with resources for food distribution (Objective). Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption in a sanitary manner.	C		Requirement MNS.1.2.2.2 HASS Food Distribution Requirement SYS.1.3.4.6 HASS Food Preparation, Storage and Distribution	Requirement SYS.1.3.4.6.2 Food Preparation & Distribution Kits		
SYS.1.3.4.7	Water Purification, Storage, and Distribution	The HASS shall be able to store (Threshold), distribute (Threshold), and purify (Objective) water from indigenous fresh water sources. Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.	nil		Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.7.1 Water Purification Temperature Requirement SYS.1.3.4.7.2 Water Purification Rate Requirement SYS.1.3.4.7.3.A Water Purification Quality IAW NSF P231 Requirement SYS.1.3.4.7.3.B Water Purification Quality IAW TB-MED 577 (2010) Requirement SYS.1.3.4.7.4.A HASS Water Storage Volume Requirement SYS.1.3.4.7.4.B Separate HASS Water Storage Volume per Occupant Requirement SYS.1.3.4.7.5.A Water Storage Weight Requirement SYS.1.3.4.7.5.B Water Distribution Weight Requirement SYS.1.3.4.7.6.A Water Storage Sealability Requirement SYS.1.3.4.7.6.B Water Storage Exposure to BPA Requirement SYS.1.3.4.7.6.C Water Storage Construction Exposure Requirement SYS.1.3.4.7.7 Water Storage		Function A.1.2 Operate Function A.1.2.3 Serve

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						Distribution Requirement SYS.1.3.4.7.A Water Purification Requirement SYS.1.3.4.7.B Water Storage Requirement SYS.1.3.4.7.C Water Distribution		
SYS.1.3.4.7.1	Water Purification Temperature	The HASS shall be capable of purifying indigenous fresh water sources at temperatures between 32F and 170F (Objective).	P	Below 32F water is frozen, above 170F water is sanitized per TB-MED 577 (2010)	Requirement MNS.1.2.5.1 HASS Water Purification Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.A Water Purification			
SYS.1.3.4.7.2	Water Purification Rate	The HASS shall be capable of purifying indigenous fresh water sources at a rate of 5 L/Day per user (Objective).	P	Jessica Harshman. Operational Forces Interface Group - Vehicular Mounted Combat Cooling System (VMCCS). Natick Soldier Research, Development and Engineering Center. Internal Report, January 8, 2009.	Requirement MNS.1.2.5.1 HASS Water Purification Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.A Water Purification			
SYS.1.	Water	The HASS shall be capable of purifying	C		Requirement MNS.1.2.5.1 HASS			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
3.4.7.3.A	Purification Quality IAW NSF P231	indigenous fresh water sources IAW NSF P231 to meet DOD 5 L/Day tri-service water quality standards for the duration of the operational cycle (Objective).			Water Purification Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.A Water Purification			
SYS.1.3.4.7.3.B	Water Purification Quality IAW TB-MED 577 (2010)	The HASS shall be capable of purifying indigenous fresh water sources IAW TB-MED 577 (2010) to meet DOD 5 L/Day tri-service water quality standards for the duration of the operational cycle (Objective).	C		Requirement MNS.1.2.5.1 HASS Water Purification Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.A Water Purification			
SYS.1.3.4.7.4.A	HASS Water Storage Volume	The HASS shall have capacity to store 20 liters of water for consumption, personal hygiene and food preparation (Threshold) and 40 liters of water (Objective).	C	Volume amounts per Sphere project: http://www.sphereproject.org/content/view/42/84/lang,english	Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.B Water Storage			
SYS.1.3.4.7.4.B	Separate HASS Water Storage Volume per Occupant	Four additional liters of water storage capacity per occupant shall be provided in separate containers (Threshold).	C	Volume amounts per Sphere project: http://www.sphereproject.org/content/view/42/84/lang,english	Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.B Water Storage			
SYS.1.3.4.7.5.A	Water Storage Weight	Each provision for storing water shall be man portable; weighing no more than 6 Lbs total when empty (Theshold).	C	Weight of empty Jerry can.	Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification,			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Storage, and Distribution Requirement SYS.1.3.4.7.B Water Storage			
SYS.1.3.4.7.5.B	Water Distribution Weight	Each provision for distributing water shall be man portable; weighing no more than 6 Lbs total when empty (Theshold).	C	Weight of empty Jerry can.	Requirement MNS.1.2.5.3 HASS Water Dispensing Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.C Water Distribution			
SYS.1.3.4.7.6.A	Water Storage Sealability	Provisions for storing water shall be sealable to prevent degradation of water quality when exposed to environmental operating conditions in section 3.2 (Threshold). Degradation in water quality is defined as non-compliance with TB-MED 577(2010) DOD 5 L/Day tri-service standard resulting from environmental exposure to the storage provision.	C		Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.B Water Storage			
SYS.1.3.4.7.6.B	Water Storage Exposure to BPA	HASS water storage provisions shall permit no exposure to BPA (Threshold).	C		Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.B Water Storage			
SYS.1.3.4.7.6.C	Water Storage Construction Exposure	Storage provision construction material shall not leech into the contained water when exposed to ambient temperatures in the range specified in section 3.2 (Threshold).	C		Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.B			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Water Storage			
SYS.1.3.4.7.7	Water Storage Distribution	Water storage provisions shall be capable of dispensing water directly to users for consumption without the loss of any water (Threshold).	C		Requirement MNS.1.2.5.3 HASS Water Dispensing Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution Requirement SYS.1.3.4.7.C Water Distribution			
SYS.1.3.4.7.A	Water Purification	The HASS shall be able to purify (Objective) water from indigenous fresh water sources. Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.	C		Requirement MNS.1.2.5.1 HASS Water Purification Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution	Requirement SYS.1.3.4.7.1 Water Purification Temperature Requirement SYS.1.3.4.7.2 Water Purification Rate Requirement SYS.1.3.4.7.3.A Water Purification Quality IAW NSF P231 Requirement SYS.1.3.4.7.3.B Water Purification Quality IAW TB-MED 577 (2010)		
SYS.1.3.4.7.B	Water Storage	The HASS shall be able to store (Threshold) water from indigenous fresh water sources. Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.	C		Requirement MNS.1.2.5.2.A HASS Water Storage for Consumption Requirement MNS.1.2.5.2.B HASS Water Storage for Personal Hygiene Requirement MNS.1.2.5.2.C HASS Water Storage for Food Preparation Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution	Requirement SYS.1.3.4.7.4.A HASS Water Storage Volume Requirement SYS.1.3.4.7.4.B Separate HASS Water Storage Volume per Occupant Requirement SYS.1.3.4.7.5.A Water Storage Weight Requirement SYS.1.3.4.7.6.A Water Storage Sealability Requirement SYS.1.3.4.7.6.B Water Storage Exposure to BPA Requirement SYS.1.3.4.7.6.C Water Storage Construction Exposure		
SYS.1.3.4.7.C	Water Distribution	The HASS shall be able to distribute (Threshold) from indigenous fresh water sources. Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.	C		Requirement MNS.1.2.5.3 HASS Water Dispensing Requirement SYS.1.3.4.7 Water Purification, Storage, and Distribution	Requirement SYS.1.3.4.7.5.B Water Distribution Weight Requirement SYS.1.3.4.7.7 Water Storage Distribution		
SYS.1.3.4.8	HASS Communications	HASS shall incorporate provisions for one-way (Receive) communication which has the ability to produce power for its operation organically (Threshold) and two-way communication (Objective).	C		Requirement MNS.1.2.3.1 One-Way Communications Requirement MNS.1.2.3.2 Two-Way Communications Requirement SYS.1.3.4 Design			Function A.1.2 Operate Function A.1.2.3 Serve
SYS.1.3.4.9.A	Natural Lighting	The HASS shall be capable of providing natural light to the internal volume	C		Requirement MNS.1.2.4.1 HASS Natural Lighting Requirement			Function A.1.2

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		(Threshold).			SYS.1.3.4 Design			Operate Function A.1.2.3 Serve
SYS.1.3.4.9.B	Natural Lighting Adjustment	The HASS shall have provisions to adjust the amount of natural light entering the HASS from 0% to 100%.	C		Requirement MNS.1.2.4.2 HASS Natural Lighting Adjustment Requirement SYS.1.3.4 Design			
SYS.1.3.4.9.C	Securing HASS Natural Lighting	Provisions for providing natural light shall be securable and closable (Objective).	C		Requirement MNS.1.2.4.2 HASS Natural Lighting Adjustment Requirement MNS.1.2.6 Security Requirement SYS.1.3.4 Design			
SYS.1.3.4.9.D	Secured Natural Lighting Opaque	When secured and closed, provisions for natural lighting shall be opaque.	C		Requirement MNS.1.2.6 Security Requirement MNS.1.2.11 Occupant Privacy Requirement SYS.1.3.4 Design			
SYS.1.3.4.10	Artificial Lighting	The HASS shall have provisions for artificial lighting (Objective).	C		Requirement MNS.1.2.4.3 HASS Artificial Lighting Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.10.1 Artificial Lighting Performance		Function A.1.2 Operate Function A.1.2.3 Serve
SYS.1.3.4.10.1	Artificial Lighting Performance	Artificial lighting provisions shall be capable of providing 500 LUX to all covered floor space in the HASS in accordance with MIL-STD-1472D: Table XV (Objective).	C		Requirement MNS.1.2.4.3 HASS Artificial Lighting Requirement SYS.1.3.4.10 Artificial Lighting			
SYS.1.3.4.11.1	HASS Volume Divider Division	Dividing provisions shall allow for the ¼ of the total HASS volume to be separated by internal divider while maintaining cross-ventilation.	C		Requirement MNS.1.2.11 Occupant Privacy Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4 Design			
SYS.1.3.4.11.A	HASS Occupant Privacy	The HASS shall have provisions that allow dividing of internal volume for occupant privacy (Threshold).	C		Requirement MNS.1.2.11 Occupant Privacy Requirement SYS.1.3.4 Design			Function A.1.2 Operate Function A.1.2.1 Protect
SYS.1.3.4.11.B	HASS Volume Divider Opaque	Dividing provisions shall be opaque.	C		Requirement MNS.1.2.11 Occupant Privacy Requirement SYS.1.3.4 Design			
SYS.1.3.4.12	HASS Ventilation Provisions	The HASS shall have provisions for natural ventilation.	C		Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.12.1 HASS Ventilation Size Requirement SYS.1.3.4.12.2 HASS Ventilation Performance Requirement SYS.1.3.4.12.3.A		Function A.1.2.1 Protect

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						HASS Ventilation Closure Requirement SYS.1.3.4.12.3.B HASS Ventilation Securing		
SYS.1.3.4.12.1	HASS Ventilation Size	Provisions for natural ventilation shall be achieved through an unobstructed aperture with a total area equivalent to 0.5 m^2.	P		Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4.12 HASS Ventilation Provisions			
SYS.1.3.4.12.2	HASS Ventilation Performance	The HASS shall enable interior air changes from 7 per hour to 14 per hour. Air changes should be defined using blower door at 50 Pa pressure difference. This may be calculated using the equation N = 60 Q / V where: N = number of air changes per hour; Q = volumetric flow rate of air in cubic metres per minute; and V = space volume in cubic meters in accordance with Transitional Shelter Standards Version 10B (2010).	P		Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4.12 HASS Ventilation Provisions			
SYS.1.3.4.12.3.A	HASS Ventilation Closure	Provisions for natural ventilations shall be capable of being closed.	C		Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4.12 HASS Ventilation Provisions			
SYS.1.3.4.12.3.B	HASS Ventilation Securing	Provisions for natural ventilations shall be capable of being secured.	C		Requirement MNS.1.3.1 Ventilation Provisions Requirement SYS.1.3.4.12 HASS Ventilation Provisions			
SYS.1.3.4.13.1.A	Scalability and Modularity Interface Size for Movement	The HASS shall have an interface that allows adequate clearance for movement to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).	C		Requirement MNS.1.2.8.1.A Operability by 5th Percentile Female Requirement MNS.1.2.8.1.B Operability by 95th Percentile Male Requirement MNS.1.2.8.1.C Maintainability by 5th Percentile Female Requirement MNS.1.2.8.1.D Maintainability by 95th Percentile Male Requirement MNS.1.2.8.2.A Clearance for Movement Requirement SYS.1.3.4.13.A HASS-to-HASS Shelter Connections			
SYS.1.3.4.13.1.B	Scalability and Modularity Interface Size for	The HASS shall have an interface that allows adequate clearance for ingress/egress to the adjacent HASS in an erect stance in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th	C		Requirement MNS.1.2.8.1.A Operability by 5th Percentile Female Requirement MNS.1.2.8.1.B Operability by 95th Percentile Male Requirement			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Ingress/Egress	percentile male).			MNS.1.2.8.1.C Maintainability by 5th Percentile Female Requirement MNS.1.2.8.1.D Maintainability by 95th Percentile Male Requirement MNS.1.2.8.2.B Clearance for Ingress/Egress Requirement SYS.1.3.4.13.A HASS-to-HASS Shelter Connections			
SYS.1.3.4.13.A	HASS-to-HASS Shelter Connections	The HASS shall connect to another of the same type to increase the covered area.	C		Requirement MNS.1.3.2.1 Connecting HASS Shelters Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.13.1.A Scalability and Modularity Interface Size for Movement Requirement SYS.1.3.4.13.1.B Scalability and Modularity Interface Size for Ingress/Egress		Function A.1.1 Deploy Function A.1.1.4 Provide Scalable Operation
SYS.1.3.4.13.B.1	Component Means to Connect HASS Shelters	It shall be possible to connect the shelters using the components provided with the HASS.	C		Requirement MNS.1.3.2.2 Means for connecting HASS Shelters Requirement SYS.1.3.4 Design			
SYS.1.3.4.13.B.2	Tool Means to Connect HASS Shelters	It shall be possible to connect the shelters using the tools provided with the HASS.	C		Requirement MNS.1.3.2.2 Means for connecting HASS Shelters Requirement SYS.1.3.4 Design			
SYS.1.3.4.14.1.A	HASS Spacial Clearance for Movement	The HASS shall ensure adequate clearance for movement in an erect stance.	C		Requirement MNS.1.2.8.2.A Clearance for Movement Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.1.B	HASS Spacial Clearance for Ingress/Egress	The HASS shall ensure adequate clearance to ingress/egress work area in an erect stance.	C		Requirement MNS.1.2.8.2.B Clearance for Ingress/Egress Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.1.C	HASS Spacial Clearance	The HASS shall ensure adequate clearance to perform all required tasks in an erect stance.	C		Requirement MNS.1.2.8.2.C Clearance for Task Performance Requirement SYS.1.3.4.14.A			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	for Task Performance				HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.2	Emergency Egress Time	The HASS shall allow users to exit the shelter when all doors are secured within 30 seconds in accordance with Transitional Shelter Standards Version 10B (2010).	P		Requirement MNS.1.2.7 Safety Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.3.A	Inseparable Assembly Weight	Each inseparable assembly of the HASS which must be moved into place for construction shall weigh no more than 74 Lbs.	C		Requirement MNS.1.2.8.3 Two Person Lift Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.3.B	Separable Assembly Weight	Each separable component of the HASS which must be lifted during the construction phase shall weigh no more than 74 Lbs.	C		Requirement MNS.1.2.8.3 Two Person Lift Requirement SYS.1.3.4.14.A HASS Human Factors Operability Requirement SYS.1.3.4.14.B HASS Human Factors Maintainability			
SYS.1.3.4.14.A	HASS Human Factors Operability	The HASS shall be operable by adults when considering the full range of anthropometric measurements in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).	C		Requirement MNS.1.2.8.1.A Operability by 5th Percentile Female Requirement MNS.1.2.8.1.B Operability by 95th Percentile Male Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.14.1.A HASS Spacial Clearance for Movement Requirement SYS.1.3.4.14.1.B HASS Spacial Clearance for Ingress/Egress Requirement SYS.1.3.4.14.1.C HASS Spacial Clearance for Task Performance Requirement SYS.1.3.4.14.2 Emergency Egress Time Requirement SYS.1.3.4.14.3.A Inseparable Assembly Weight Requirement SYS.1.3.4.14.3.B Separable Assembly Weight		
SYS.1.3.4.14.B	HASS Human Factors Maintainability	The HASS shall be maintainable by adults when considering the full range of anthropometric measurements in accordance with MIL-STD-1472D Section 5.14.2.3 (5th percentile female through 95th percentile male).	C		Requirement MNS.1.2.8.1.C Maintainability by 5th Percentile Female Requirement MNS.1.2.8.1.D Maintainability by 95th Percentile Male Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.14.1.A HASS Spacial Clearance for Movement Requirement SYS.1.3.4.14.1.B HASS Spacial Clearance for Ingress/Egress Requirement SYS.1.3.4.14.1.C HASS Spacial Clearance for Task Performance Requirement		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						SYS.1.3.4.14.2 Emergency Egress Time Requirement SYS.1.3.4.14.3.A Inseparable Assembly Weight Requirement SYS.1.3.4.14.3.B Separable Assembly Weight		
SYS.1.3.4.15.1	HASS Vibration Safety During Operation	The HASS shall not allow components of the HASS to become dislodged in its operational configuration when exposed to vibration conditions as stated in Section 3.3.5 of this specification.	P		Requirement MNS.1.1.1 Operational Environment Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			
SYS.1.3.4.15.2	HASS Tripping Safety Hazards	The HASS shall prevent tripping hazards. For example, doorways, aisles, and walkways will be free of tripping hazards such as thresholds, cords, hoses, steps and other projections.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.3.A	HASS Sharp Edge Hazards	The HASS shall be free of sharp edges.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement MNS.1.2.7.1.D			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
					Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.3.B	HASS Pointed Projection Hazards	The HASS shall be free of pointed projections.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.4	HASS Exposed Moving Part	The HASS shall not have any exposed moving parts, which could injure personnel.	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Hazards				to Maintainers During Use Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.5.1.A	HASS Storage Safety of Warehouse Personnel	The HASS shall prevent warehouse personnel from injury during its storage.	C		Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.5.1.B	HASS Transport Safety of Warehouse Personnel	The HASS shall prevent warehouse personnel from injury during its transport.	C		Requirement MNS.1.2.7.1.G Minimize Hazards to Handling Personnel During Transport Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.5.1.C	HASS Storage Safety of Maintenance Personnel	The HASS shall prevent maintenance personnel from injury during its storage.	C		Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			
SYS.1.3.4.15.5.1.D	HASS Transport Safety of Maintenance Personnel	The HASS shall prevent maintenance personnel from injury during its transport.	C		Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			
SYS.1.3.4.15.5.2	Forklift Use to Move	Forklift movements shall not cause any components of the HASS to become dislodged from its packaging.	C		Requirement MNS.1.1.3.D Ground Transportability Requirement MNS.1.2.7.1.G			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	HASS				Minimize Hazards to Handling Personnel During Transport Requirement SYS.1.3.4.15.C HASS Safety for Transportation Handlers			
SYS.1.3.4.15.6.1	Vector-Born Disease Protection	The HASS shall provide occupants protection from vector-borne disease by preventing carrying vectors from entering shelter (e.g snakes, scorpions, rats, mosquitoes) in accordance with Oxfam Transitional Settlement Displaced Populations dated 2005.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			Function A.1.2.1 Protect
SYS.1.3.4.15.6.2.A	HASS Opening Barrier Type I	Any opening in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with knitted polyester yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.B	HASS Opening Barrier Type II	Any opening in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with plastic-coated yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.C	HASS Opening Barrier Type III	Any opening in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with impregnated fiber-glass yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.D	HASS Seam Barrier Type I	Any seam in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with knitted polyester yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.E	HASS Seam Barrier Type II	Any seam in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with plastic-coated yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.	HASS Seam	Any seam in the HASS structure which is not an entryway and is greater than 6mm	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
6.2.F	Barrier Type III	(.236 in) in diameter shall be secured with impregnated fiber-glass yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.			Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.G	HASS Gap Barrier Type I	Any gap in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with knitted polyester yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.H	HASS Gap Barrier Type II	Any gap in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with plastic-coated yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.6.2.I	HASS Gap Barrier Type III	Any gap in the HASS structure which is not an entryway and is greater than 6mm (.236 in) in diameter shall be secured with impregnated fiber-glass yarn netting/mesh with a size equal to or smaller than 12 x 13 holes per square inch.	C		Requirement MNS.1.2.7.4 Vector-borne Disease Protection Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.7	Unsafe Conditions during Maintenance	Users shall be able to maintain the HASS without being exposed to unsafe conditions.	C		Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			
SYS.1.3.4.15.8.A	HASS Component Location Safety	The HASS shall identify interior components so as to prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death.	C		Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement MNS.1.2.7.3.A Component Identification Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.8.B	Component Location Safety	The HASS shall locate interior components so as to prevent injury to users in case of an emergency. Emergency is defined as any situation which will cause the user bodily harm or death.	C		Requirement MNS.1.2.7.3.B Component Location Requirement SYS.1.3.4.15.A HASS Safety for Occupants			
SYS.1.3.4.15.9	HASS Toxic Gas Limits	The HASS internal volume shall meet OSHA threshold limit values for all toxic gases IAW Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000	C		Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.1.C Minimize Hazards			

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
		TABLE Z-1 dated 1998.			to Maintainers During Use Requirement MNS.1.2.9.1.A Materials Hazardous to Health per NEPA Requirement MNS.1.2.9.1.C Materials Hazardous to Health per International Standards Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			
SYS.1. 3.4.15. 10	HASS Security	Any opening of the HASS which is large enough to accommodate a 5th percentile female in IAW the U.S. Army's 1998 Anthropometric Survey shall be securable to impede unwanted entry (Objective).	C		Requirement MNS.1.2.6 Security Requirement MNS.1.2.7 Safety Requirement SYS.1.3.4.15.A HASS Safety for Occupants Requirement SYS.1.3.4.15.B HASS Safety for Maintainers			Function A.1.2 Operate
SYS.1. 3.4.15. A	HASS Safety for Occupants	The HASS shall incorporate safety features/capabilities to protect occupants.	C		Requirement MNS.1.2.7.1.A Occupant Protection During Use Requirement MNS.1.2.7.1.B Minimize Hazards to Users During Use Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.15.1 HASS Vibration Safety During Operation Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.6.1 Vector-Born Disease Protection Requirement SYS.1.3.4.15.6.2.A HASS Opening Barrier Type I Requirement SYS.1.3.4.15.6.2.B HASS Opening Barrier Type II Requirement SYS.1.3.4.15.6.2.C HASS Opening Barrier Type III Requirement SYS.1.3.4.15.6.2.D HASS Seam Barrier Type I Requirement SYS.1.3.4.15.6.2.E HASS Seam Barrier Type II Requirement	Issue Issue.24 -> SYS-FUNC - Missing Requirement (s) for Shelter Insulation/Temperature Regulation	Function A.1.2 Operate Function A.1.2.1 Protect

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
						SYS.1.3.4.15.6.2.F HASS Seam Barrier Type III Requirement SYS.1.3.4.15.6.2.G HASS Gap Barrier Type I Requirement SYS.1.3.4.15.6.2.H HASS Gap Barrier Type II Requirement SYS.1.3.4.15.6.2.I HASS Gap Barrier Type III Requirement SYS.1.3.4.15.8.A HASS Component Location Safety Requirement SYS.1.3.4.15.8.B Component Location Safety Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits Requirement SYS.1.3.4.15.10 HASS Security		
SYS.1.3.4.15.B	HASS Safety for Maintainers	The HASS shall incorporate safety features/capabilities to protect maintainers.	C		Requirement MNS.1.2.7.1.C Minimize Hazards to Maintainers During Use Requirement MNS.1.2.7.1.D Minimize Hazards to Maintainers During Storage Requirement MNS.1.2.7.1.E Minimize Hazards to Maintainers During Transport Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.15.1 HASS Vibration Safety During Operation Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.C HASS Storage Safety of Maintenance Personnel Requirement SYS.1.3.4.15.5.1.D HASS Transport Safety of Maintenance Personnel Requirement SYS.1.3.4.15.7 Unsafe Conditions during Maintenance Requirement SYS.1.3.4.15.9 HASS Toxic Gas Limits Requirement SYS.1.3.4.15.10 HASS Security		
SYS.1.3.4.15.C	HASS Safety for Transportation	The HASS shall incorporate safety features/capabilities to protect transportation handlers.	C		Requirement MNS.1.2.7.1.F Minimize Hazards to Handling Personnel During Storage Requirement MNS.1.2.7.1.G	Requirement SYS.1.3.4.15.2 HASS Tripping Safety Hazards Requirement SYS.1.3.4.15.3.A HASS Sharp Edge Hazards		

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Handlers				Minimize Hazards to Handling Personnel During Transport Requirement MNS.1.2.7.2.A Warning Labels Requirement MNS.1.2.7.2.B Warning Indicators Requirement SYS.1.3.4 Design	Requirement SYS.1.3.4.15.3.B HASS Pointed Projection Hazards Requirement SYS.1.3.4.15.4 HASS Exposed Moving Part Hazards Requirement SYS.1.3.4.15.5.1.A HASS Storage Safety of Warehouse Personnel Requirement SYS.1.3.4.15.5.1.B HASS Transport Safety of Warehouse Personnel Requirement SYS.1.3.4.15.5.2 Forklift Use to Move HASS		
SYSCOMPONENT.1	HASS Transport Packaging		nil					
SYSCOMPONENT.2	HASS Shelter Structure		nil					
SYSCOMPONENT.3	HASS Shelter Storage		nil					
SYSCOMPONENT.4	HASS Food Preparation, Storage & Distribution		nil					
SYSCOMPONENT.5	HASS Water Purification, Storage & Distribution		nil					
SYSCOMPONENT.6	HASS Communication		nil					
SYSCOMPONENT.7	HASS Lighting		nil					
SYSCOMPONENT.8	HASS Construction,		nil					

Req. #	Req. Name	Requirement Text	Req. Type	Rationale	Traces Up	Traces Down	Issues Generated	Links
	Disassembly and Maintenance Tools							

APPENDIX N: MNS & SYSTEM REQUIREMENTS DEFINED TERMS CORE EXPORT

Appendix N – HASS Mission Needs Statement and System Specification Defined Terms

Term Number	Term Identification	Term Definition
DefinedTerm.1	-> Operational Usage Duration	Operational duration is defined as any time outside of shelf time (pre-deployment storage time).
DefinedTerm.2	-> Essential Functional Failure	An essential functional failure is a failure of certain major components or systems of the HASS that cannot be repaired by the user.
DefinedTerm.3	-> Major Components	Major components are defined as any component in which a failure leads to the shelter being uninhabitable.
DefinedTerm.4	-> Terrain	Terrain is defined as various degrees of slopes and ground conditions consisting of muddy, grassy, hard, and sandy surfaces.
DefinedTerm.5	-> Food Distribution	Food distribution is defined as distributing hot, cold, cooked, solid, or liquid food to the user for consumption in a sanitary manner.
DefinedTerm.6	-> Emergency	Emergency is defined as any situation which will cause the user bodily harm or death.
DefinedTerm.7	-> Flammable	Flammable is defined as any material having a flashpoint below 100 deg F and a boiling point greater than 100 deg F.
DefinedTerm.8	-> Combustibility	Combustibility is defined as a material having flashpoint of 100deg F to 200 deg F. Alternatively, Combustibility is defined as any material having a rating of Class II, or III IAW OSHA 1926.152 flammability and combustibility classification system.
DefinedTerm.9	-> Salt fog Degradation	Salt fog degradation is defined as reducing the yield strength of the material by no more than 10% of any structural component (Threshold) and 5% (Objective).
DefinedTerm.10	-> Functional capacity	Functional capacity is defined as the HASS' ability to operate in conformance with environmental conditions specified in section SYS.1.3.2.
DefinedTerm.11	-> Covered Floor Space	Covered floor space is defined as floor space which separates the HASS' users from the environmental operating conditions stated in section SYS.1.3.2.
DefinedTerm.12	-> COTS Components	Commercial-Off-The-Shelf (COTS) components are defined as readily available components or assemblies which require no modifications or development to integrate.
DefinedTerm.13	-> Standard Pallet Size	Standard pallet size is defined as 48" x 45" with standard forklift pocket dimensions IAW ISO Standard 1496-1 (1990).
DefinedTerm.14	-> Food Storage	Food storage is defined as storing hot, cold, cooked, solid, or liquid food for consumption by the user
DefinedTerm.15	-> Food Preparation	Food preparation is defined as the capability to boil, braise, pan fry and griddle.

DefinedTerm.16	-> Food Preparation Net Efficiency	Food Preparation Net efficiency is defined as 2946.5 Btu divided by total energy content of fuel used to bring 2.5 gallons of water to a boil.
DefinedTerm.17	-> Indigenous Fresh Water Sources	Indigenous fresh water sources are defined as any natural fresh water source, i.e.: wells, rivers, lakes, and streams.
DefinedTerm.18	-> Water Quality Degradation	Degradation in water quality is defined as non-compliance with TB-MED 577(2010) DOD 5 L/Day tri-service standard resulting from environmental exposure to the storage provision.
DefinedTerm.19	-> Operation	Operation is defined as using the HASS structure or its components for their intended purposes in their prescribed operational environments.
DefinedTerm.20	-> Internal Air Changes	Air changes should be defined using blower door at 50 Pa pressure difference. This may be calculated using the equation N = 60 Q / V where: N = number of air changes per hour; Q = volumetric flow rate of air in cubic metres per minute; and V = space volume in cubic meters in accordance with Transitional Shelter Standards Version 10B (2010).
DefinedTerm.21	-> Preventive Maintenance Actions in Storage	Preventive maintenance actions in storage are defined as detailed inspections/system checkout and scheduled safety inspections.
DefinedTerm.22	-> Preventive Maintenance Actions in Operations	Preventive maintenance actions in operations are defined as visual inspections and external adjustments.

LIST OF REFERENCES

ANSI/EIA-649-1998 National Consensus Standard for Configuration Management. American National Standards Institute

ANSI/UL 263 (2001) Fire Resistance Ratings. American National Standards Institute

ASTM F-1275-03 Standard Method for Performance of Griddles, American Society for Testing and Materials

ASTM D6413-94 Vertical Flame Chamber American Society for Testing and Materials

FED-STD-595C Colors Used in Government Procurement, January 16, 2008 http://www.nstcenter.com/docs/PDFs/TechResources-FederalStandard595C.pdf (accessed January 2011)

ISO 3864-2:2004 Graphical Symbols-Safety Colors and Signs, http://www.iso.org/iso/ (accessed July 2011)

ISO 1496-1:1990 Series 1 freight containers -- Specification and testing -- Part 1: General cargo containers for general purposes

ISO 9000 essentials. http://www.iso.org/iso/iso_9000_essentials (accessed January 2011)

ISO 10006:2003 Quality Management Systems -- Guidelines for Quality Management in Projects. http://www.iso.org/iso/catalogue_detail.htm?csnumber=36643

MIL-HDBK-61A(SE) Configuration Management Handbook. Department of Defense, 7 Feb 2001

MIL-STD 882, Standard Practice for System Safety, Department of Defense, 10 Feb 2000

MIL-STD-810G Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests. Department of Defense, 31 Oct 2008

MIL-STD-130M Department of Defense Standard Practice-Identification Marking of U.S. Military Property, Department of Defense, 2 Dec 2005

MIL-STD-1472D Department of Defense Design Criteria for Human Engineering, Department of Defense, 23 Aug 1999

NSF Protocol 231 Microbiological Water Purifiers, http://www.nsf.gov (accessed January 2011).

OSHA 1926.152 Safety and Health Regulations for Construction, Occupational Safety & Health Administration,

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10673 (accessed July 2011)

OSHA CFR 29 OSHA Toxic and Hazardous Substances Standard Number: CFR 29, Parts 1910.1000 TABLE Z-1 Occupational Safety & Health Administration, http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992, *d*ated 1998,

TB MED 577 Sanitary Control and Surveillance of Field Water Supplies. Department of the Army, December 2005.

UNHCR. 2011. http://www.unhcr.org/pages/49c3646c2.html (accessed March 5, 2011).

Ace Hardware Superstore. *Eton FR 360.* 2011. http://www.acehardwaresuperstore.com/dynamo-crank-powered/7609.html (accessed August 30, 2011).

Amazon. *Grundig G6 Aviator Aircraft Shortware.* 2011. http://www.amazon.com/Grundig-G6-Aviator-aircraft-Shortwave/dp/B0014T5UM4 (accessed August 30, 2011).

—. *Kaito KA1002 Portable Radio.* 2011. http://www.amazon.com/Kaito-KA1102-Portable-radio/dp/B00065X51U (accessed August 30, 2011).

—. *Kaito KA1101 Protable Radio.* 2011. http://www.amazon.com/Kaito-KA1101-Portable-radio/dp/B000669GA8 (accessed August 30, 2011).

—. *Midland GXT1000VP-4.* 2011. http://www.amazon.com/Midland-GXT1000VP4-36-Mile-50-Channel-Two-Way/dp/B001WMFYH4 (accessed August 30, 2011).

—. *Midland XT511.* 2011. http://www.amazon.com/Midland-XT511-22-Channel-Two-Way-Emergency/dp/B000P0O12I (accessed August 30, 2011).

—. *Motorola MR350R.* 2011. http://www.amazon.com/Motorola-MR350R-35-Mile-22-Channel-Two-Way/dp/B001UE6MJ8 (accessed August 30, 2011).

—. *Sangean ATS 505.* 2011. http://www.amazon.com/Sangean-ATS-505P-Stereo-Synthesized-Receiver/dp/B000066R6K (accessed August 30, 2011).

—. *Sangean ATS-404.* 2011. http://www.amazon.com/Sangean-ATS-404-Digital-Shortwave-Receiver/dp/B0000226L0 (accessed August 30, 2011).

Aqua Sun. 2011. http://www.aqua-sun-intl.com/portable-water-purification-systems/fresh-water-systems/outpost-s (accessed August 26, 2011).

Barnes & Noble. *Eton Traveler II Digital G8 Radio Tuner.* 2011. http://gifts.barnesandnoble.com/Eton-Traveler-II-Digital-G8-Radio-Tuner/e/750254803895?r=1&cm_mmc=Google%20Product%20Search-_-

Q000000630-_-Eton%20Traveler%20II%20Digital%20G8%20Radio%20Tuner-_-750254803895 (accessed August 30, 2011).

bhphotovideo. *SW7600GR FM Stereo World.* 2011. http://www.bhphotovideo.com/c/product/642936-REG/Sony_ICFSW7600GR_ICF_SW7600GR_FM_Stereo_World.html (accessed August 30, 2011).

Cambro Manufacturing Company. 2011. http://cool.cambro.com/Poly_Rounds_Round_Storage_Containers_and_Lids_Storage.ashx (accessed August 26, 2011).

Cambro Manufacturing Company. 2011. http://cool.cambro.com/product_line.aspx?rrn=2&plrn=55 (accessed August 26, 2011).

Cannon, Major Monte. "Systems Engineering for Rapid Prototyping: Friendly Marking Device." *Air Force Institute of Technology (AFIT).* 2011. http://www.afit.edu/cse/docs/presentations/NDIA%20SE%2006%20-%20FMD_Brief.pdf (accessed Janurary 15, 2011).

Cobra. *MicroTalk CXR800.* 2011. https://www.cobra.com/detail/microtalk-cxr800-27-mile-radio-with-weather.cfm (accessed August 30, 2011).

CSN Stores. *Cadac Safari Chef Camping Stove - 6541B.* 2002-2011. http://www.csnstores.com/Cadac-Safari-Chef-Camping-Stove-6541B-CAD1000.html (accessed May 26, 2011).

Cymax. *Camp Chef Alpine Heavy Duty Outdoor Free Standing Cylinder Stove in Black* . 2005-2011. http://www.cymax.com/Common/Product/CatProduct.aspx?ID=242728&Src=SortPrice&SrcID=4178873 (accessed May 26, 2011).

D.Guha-Sapir, D. P. *Thirty Years of Natural Disasters 1974-2003: The Numbers.* Belgium: Presses universitaires de Louvain, 2004.

DAU - Ask A Professor. https://dap.dau.mil/aap/pages/qdetails.aspx?cgiSubjectAreaID=24&cgiQuestionID=22943 (accessed July 2011).

Defense & Military - Camps and Real-life support Systems. http://www.atcosl.com/en-ca/Products-and-Services/Industry/Defense.htm?gclid=CJ_wwdmK46YCFRVx5QodxG3Q2g (accessed Janurary 2011).

Defense Acquisition Guidebook. Defense Acquisition University. https://dag.dau.mil/Pages/Default.aspx (accessed Januraty 2011).

Dlight Design Company. 2011. http://www.dlightdesign.com (accessed August 29, 2011).

D'Lugos, Susan Leigh, interview by Paul Lee. *Modular Tactical Vest (MTV) Shipping Estimations by Pallet* (August 2011).

Emergency Shelter Village. May 17, 2011. http://calearth.org/galleries/emergency-shelter-village.html (accessed May 17, 2011).

Emergency Shelter and Disaster Relief for the People of Haiti. Janurary 14, 2010. http://inhabitat.com/emergency-shelters-and-disaster-relief-for-the-people-of-haiti/ (accessed Janurary 2011).

Eton Corporation. *Eton FR360.* 2011. http://www.etoncorp.com/product_card/?p_ProductDbId=915826 (accessed August 30, 2011).

Even Shelters. May 17, 2011. http://live.justice-roche.com/evenproducts/uploads/evenshelter.pdf (accessed May 17, 2011).

Fabrycky, Benjamin S. Blanchard and Wolter J. *Systems Engineering and Analysis Fourth Edition.* Upper Saddle River, New Jersey 07458: Pearson Prentice Hall, 2006.

Flexayurt. 2011. http://www.homergent.com/products/flexayurt (accessed May 12, 2011).

General Ecology. 2011. http://generalecology.com/category/portable/product/first_need_base_camp_portable_purifier (accessed August 26, 2011).

Griffin, M. *Two Story T Shelter, Engineering Review: Shelter Structure.* Engineering Review, Bayside, CA 95524: Engineering Review International, 2010.

Hasanco Group. 2011. http://hasancogroup.com/ICRC_IFRC_Type_Kitchen_Sets.html (accessed August 26, 2011).

HDT Base-X® Model 303. May 17, 2011. http://www.hdtglobal.com/products/shelters/base-xreg-shelters/hdt-base-xreg-model-303/ (accessed May 17, 2011).

HDT Base-X® Model 505. May 17, 2011. http://www.hdtglobal.com/products/shelters/base-xreg-shelters/hdt-base-xreg-model-505/ (accessed May 17, 2011).

Hexayurtcity. 2011. http://www.choices.co.uk/blog/6-sustainable-housing-solutions-to-weather-natures-fury-4511 (accessed May 12, 2011).

IASC. 2011. http://www.humanitarianinfo.org/iasc/ (accessed March 5, 2011).

International Federation of Red Cross and Red Crescent Societies (ICRC). *Stove, firewood, heating and cooking* . January 1, 2011. http://procurement.ifrc.org/catalogue/detail.aspx?volume=1&groupcode=108&familycode=108005&categorycode=STOH&productcode=HHEASTOH01 (accessed May 26, 2011).

International Federation of Red Cross and Red Crescent Societies. 2011. http://procurement.ifrc.org/catalogue/detail.aspx?volume=1&groupcode=108&familycode=108001&categorycode=COOS&productcode=KRELCOOSETA (accessed August 26, 2011).

Jamieson, Louis, interview by Ben Williams. *Master Chief (Navy Master Chief Culinary Specialist)* (May 5, 2011).

Katadyn . 2011. http://www.katadyn.com/usen/katadyn-products/products/katadynshopconnect/katadyn-water-filters-endurance-series-products/katadyn-expedition/ (accessed August 26, 2011).

Katadyn. 2011. http://www.katadyn.com/usen/katadyn-products/products/katadynshopconnect/katadyn-desalinators-manual-survivors/katadyn-survivor-35/ (accessed August 26, 2011).

Katadyn Group. 2011. http://www.katadynmilitary.com/en/military-products/products/katadynshopconnect/military-katadyn-wasserfilter-2/katadyn-pocket-armee/ (accessed August 26, 2011).

Katadyn Group. 2011. http://www.katadynmilitary.com/en/military-products/products/katadynshopconnect/military-katadyn-wasserfilter-2/katadyn-camp/ (accessed August 26, 2011).

Klingshirn, Dan, Charles Setchell, Matt Myrick, and Renee Van Slate, interview by Whitney Kemmey. *Stakeholders* (March 16, 2011).

Kwinn, Brigitte. "Fundamentals of Systems Engineering." *SE3100.* Fall Semester 2009.

Maddel International. *Maddelinternational.com.* 2011. http://www.maddelinternational.com/ (accessed 2011).

Margesson, Rhoda, and Maureen Taft-Morales. "Haiti Earthquake: Crisis and Response." *Federation of American Scientists.* 2011. http://www.fas.org/sgp/crs/row/R41023.pdf.

McGeoch LED. 2011. http://www.mcgeochLED.com (accessed August 29, 2011).

Midland Radio. *GXT1000VP4.* 2011. http://www.midlandradio.com/New-Arrivals2.K16/GXT1000VP4 (accessed August 30, 2011).

—. *XT511 Base Camp.* 2011. http://www.midlandradio.com/Two-Way-Radio.BS3/XT511-Base-Camp (accessed August 30, 2011).

MOCO Company. 2011. http://www.moco.com (accessed August 29, 2011).

Monolithic. 2011. http://shop.monolithic.com/collections/emergency-preparedness/products/just-water-complete-bucket-system (accessed August 26, 2011).

Motorola. *MR350R-VP.* 2011. http://www.motorola.com/Business/US-EN/Business+Product+and+Services/Two-Way+Radios+-+Consumers/MR350R-VP_Talkabout_Two-Way-Radio_US-EN (accessed August 30, 2011).

Naidoo, Pat, and Regan Pontangaroa. "Regan“TWiG: “t” Shelter Update”,." https://1167483888581526295-a-1802744773732722657-s-sites.googlegroups.com/site/shelterhaiti2010/files/TShelterComparativeSurveypresentation.pdf?attachauth=ANoY7coqjwHS1utDyG-fklBF5BfZyVn_IEi66tlZyEuf880dUuMU9 SUlZj9duNtOMYN su13IlDSmrgZOhUPTJDn07U2TSwl-jJADsFB44antk9r1DNjN6sT95blOqRoD9W5 moNJyn FhGq2uAe0DjXRExvTOuVafEpo8Cql9AOEiWA2GLi9AwJH_SlxkSRaqvwMsFyw5zuY5TAao4qVipIxV472GYV-ILSKCmAo0TiFZwh3L57gKYCnU_wqGY5H3Oiyl3AMT dNGJP &attredirects=0(accessed July 25, 2011).

NRS International. *TransHomes® - Transformable Shelter.* 2011. http://www.dinsons.com/nrs/trans-homes (accessed May 12, 2011).

—. *TransHomes® - Transformable Shelter.* 2011. http://www.dinsons.com/nrs/trans-homes (accessed May 12, 2011).

Nunatak Systems. *NunatakSystems.eu.* 2010. http://www.nunataksystems.eu/www.nunataksystems.eu/TS200.html (accessed 2011).

Oxley Group. 2011. http://www.oxleygroup.com/getdoc/05a132fa-1e67-4cd5-8f0f-aa187792b810/SHEL.aspx (accessed August 29, 2011).

P248 Emergency Military Operations Microbiological Water Purifiers. Ann Arbbor MI: National Sanitation Foundation, January 2006.

Potable Aqua. 2011. http://www.potableaqua.com/products-chlorine-dioxide.php (accessed August 26, 2011).

Prefab Friday Reaction Housing Emergency Shelters. November 28, 2008. http://inhabitat.com/prefab-friday-reaction-housing-emergency-shelters/ (accessed Janurary 2011).

REI. 2011. http://www.rei.com/product/767831/first-need-xl-water-purifier (accessed August 26, 2011).

REI. *Motorola MR350R.* 2011. http://www.rei.com/product/793588/motorola-mr350r-2-way-radios-pair (accessed August 30, 2011).

Reliance. *Fold-A-Carrier II Blue 5G/20L (00510017).* 2006. http://www.relianceproducts.com/products/hydration/87.html (accessed May 26, 2011).

Rhodes, Mark. "System Assessment." *SE 3303.* Spring Semester 2010.

Rubbermaid. 2011. http://www.rubbermaid.com/Category/Pages/ProductDetail.aspx?CatName=shoponline&SubcatId=ShopOnlineFoodStorage&Prod_ID=RP091258 (accessed August 26, 2011).

Rubbermaid For Less. 2011. http://www.rubbermaidforless.com/rubbermaid-5725-5723-572324-5724-572424-round-storage-containers-1025-product_info-933.html (accessed August 26, 2011).

Scepter. *Scepter Military - Water Canisters.* 2007. http://www.sceptermilitary.com/water_containers/ (accessed May 26, 2011).

Series 1100 Emergency/Transitional Shelter. 2011. http://www.alibaba.com/product-free/106535229/Series_1100_Emergency_Transitional_Shelter.html (accessed May 12, 2011).

Sheard, Sarah A. *Systems Engineering Standards and Models Compared.* 1998. citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.121 (accessed Janurary 28, 2011).

Shelter Centre. *Transitional Shelter Prototypes.* November 2009. http://sheltercentre.org/library/transitional-shelter-prototypes-09b (accessed May 12, 2011).

—. *Transitional Shelter Standards.* December 2010. http://sheltercentre.org/library/transitional-shelter-standards-10b (accessed May 17, 2011).

Shelter Centre. *Transitional Shelter Standards 10b.* Shelter Centre, 2010.

Shelter MK 2. May 12, 2011. http://www.maddelinternational.com/index.php?option=com_content&view=article&id=75&Itemid=77 (accessed May 12, 2011).

Shelter MK 5. May 12, 2011. http://www.maddelinternational.com/index.php?option=com_content&view=article&id=77&Itemid=77 (accessed May 12, 2011).

Sphere Project. "The Sphere Project Handbook 2011." *Sphereproject.org.* 2011. http://www.sphereproject.org/dmdocuments/The_Sphere_Project_Handbook_2011.zip (accessed July 25, 2011).

Sphere. *The Sphere Handbook -- Humanitarian Charter and Minimum Standardsin Disaster Response.* The Sphere Project, 2004.

SteriPEN. 2011. http://www.steripen.com/-adventurer-opti-solar-charger (accessed August 26, 2011).

SteriPEN. 2011. http://www.steripen.com/sidewinder (accessed August 26, 2011).

Survival Equipment . 2011. http://www.survivalequipment.net/utensils.html (accessed August 26, 2011).

Survival Equipment. 2011. http://www.survivalequipment.net/cookware2.html (accessed August 26, 2011).

System Engineering Handbook, V3, 2010. International Council on Systems Engineering (INCOSE). http://www.incose.org/ProductsPubs/products/sehandbook.aspx (accessed January 2011).

Techno Relief Group. 2011. http://www.technorelief.com/household_items.html (accessed August 26, 2011).

Tozun, Ned. *President & Founder, d.light, http://www.dlightdesign.com .* Palo Alto, CA.

TranShel. May 12, 2011. http://worldshelters.org/wp-content/uploads/2010/01/haiti-relief-transhel-proposaldoc.pdf (accessed May 12, 2011).

TranShel. May 12, 2011. http://worldshelters.org/shelters/transitional-shelter (accessed May 12, 2011).

Transitional Shelter TS200. May 12, 2011. http://www.transitionalshelter.org/www.transitionalshelter.org/TS_gallery.html (accessed May 12, 2011).

Uber Shelter Blog. May 17, 2011. http://ubershelter.blogspot.com/ (accessed May 17, 2011).

Uber Shelter. *Uber Shelter.* 2011. http://www.ubershelter.org/about.html (accessed May 17, 2011).

UN High Commissioner for Refugees. "“Handbook for Emergencies”." Vers. 2nd Edition. *The United Nations High Commissioner for Refugees (UNHCR).* 2011. http://www.unhcr.org/publ/PUBL/3bb2fa26b.pdf (accessed July 25, 2011).

UN-HABITAT and IFRC. *Shelter Projects 2008.* UN-HABITAT and International Federation of Red Cross, 2009.

UN-HABITAT and IFRC. *Shelter Projects 2009.* UN-HABITAT and International Federation of Red Cross, 2010.

"UNHCR Handbook for Emergencies." Vers. 2nd Edition. *UNHCR.* http://www.unhcr.org/publ/PUBL/3bb2fa26b.pdf (accessed March 5, 2011).

Universal Radio. *Catalog.* 2011. http://www.universal-radio.com/catalog/portable/chartp.html (accessed August 30, 2011).

USAID. *About USAID.* December 08, 2010. http://www.usaid.gov/about_usaid/ (accessed August 29, 2011).

Vehicular Mounted Combat Cooling System (VMCCS). Natick Soldier Research, Development and Engineering Center. Internal Report, January 8, 2009.

Volcano Grills. *Volcano Collapsible.* http://www.volcanogrills.com/volcano-collapsible/volcano-collapsible (accessed May 26, 2011).

Wal-mart. 2011. http://www.walmart.com/ip/Farberware-5-Mini-Chef-Knife/13435033 (accessed August 26, 2011).

Wal-mart. 2011. http://www.walmart.com/ip/Mainstays-10-Piece-Cookware-Set-Stainless-Steel/14915142 (accessed August 26, 2011).

Weatherbase. 2011. http://www.weatherbase.com/weather/weatherall.php3?s=66326&refer=&units=us (accessed June 17, 2011).

Webstaurant Store. 2011. http://www.webstaurantstore.com/13-quart-stainless-steel-utility-pail/407SP13.html (accessed August 26, 2011).

Workplace Hazardous Material Identification System (WHMIS classification system) http://www.hc-sc.gc.ca/ewh-semt/pubs/occup-travail/ref_man/ref_manual_index-eng.php (accessed July 2011)

Worldwide Shelters. *Transitional Shelters.* 2011. http://www.worldwideshelters.org/shelters.html (accessed May 12, 2011).

—. *WorldwideShelters.org.* 2011. http://www.worldwideshelters.org/ (accessed 2011).

Zoover. *Egypt Weather.* 2011. http://www.zoover.co.uk/egypt/egypt /cairo/weather (accessed June 17, 2011).

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center 2
8725 John J. Kingman Rd., STE 0944
Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library, Code 013 2
Naval Postgraduate School
Monterey, CA 93943-5100

3. Jeannie McMahon 1
Worldwide Shelters
2480 Georgia Avenue, Suite 6
Glenwood, MD 21738

4. Peyton Cascio 1
VersaTube Building Systems
50 Eastley St.
Collierville, TN 38017